ARCHIVES OF OPHTHALMOLOGY

VOLUME 23 (old series Volume 80) FEBRUARY 1940 NUMBER 2

COPYRIGHT, 1940, BY THE AMERICAN MEDICAL ASSOCIATION

ENDOPHTHALMITIS PHACOANAPHYLACTICA AND ITS RELATION TO SYMPATHETIC OPHTHALMIA

J. ARNOLD DEVEER, M.D.

BROOKLYN

It is a matter of common knowledge that some persons suffer more or less severe intraocular inflammation after accidental or surgical traumatization of the crystalline lens. Early observers had considered this reaction to be due to infection, the damaged lens furnishing a good culture medium for bacteria. Schirmer,[1] however, in 1899 reported a series of such cases in which he had found the aqueous sterile. Lagrange and Lacoste [2] in 1911 appear to have been the first to suggest that the inflammation in these cases is due to an inherent toxicity of the retained lens substance. These authors reported the occurrence of this complication at 8 of 100 cataract extractions. The "toxic theory" was advanced also by Straub,[3] who presented clinical and histologic observations and suggested the name endophthalmitis phacogenetica. It is of interest to note that Straub attempted to immunize one of his patients by subcutaneous injections of lens protein, which suggests that he may have suspected an allergic factor in the causation of the disease, but it was not until 1922 that the "anaphylactic theory" was introduced by Verhoeff and Lemoine,[4] who proposed the name endophthalmitis phacoanaphylactica.

These authors reported 12 cases of rupture of the lens capsule, traumatic, operative or spontaneous, in which there occurred intraocular inflammation due, apparently, to lens matter. Sections of enucleated eyes from 5 of the patients showed a histologic picture which was described in detail as the characteristic lesion of the disease. A positive cutaneous reaction to lens protein was later obtained in each of the 12

From the Department of Pathology of the Brooklyn Hospital and of the Brooklyn Eye and Ear Hospital.

1. Schirmer, O., cited by Verhoeff and Lemoine.[4]
2. Lagrange, H., and Lacoste, A.: Arch. d'opht. **31**:769, 1911.
3. Straub, M., cited by Verhoeff and Lemoine.[4]
4. Verhoeff, F. H., and Lemoine, A. N., in Report of the International Ophthalmological Congress, Tr. Internat. Cong. Ophth., 1922, p. 234.

cases. In 25 instances of rupture of the capsule of the lens without ensuing inflammation, dermal reactions were negative. In support of their theory, based on clinical and histologic observations, the authors attempted to reproduce the disease in animals, but the results were inconclusive. Many years later Verhoeff [5] stated: "We entirely failed to produce the phacoanaphylactic reaction in rabbits."

Further clinical observations in confirmation of this theory were offered by Lemoine and MacDonald,[6] who in 1924 reported their findings in 168 cases of rupture of the capsule of the lens. Fourteen of the patients gave positive reactions to cutaneous tests with lens protein, and in 7 of these intraocular inflammation developed. No inflammatory reactions occurred among the remaining 154 patients who gave negative reactions to the cutaneous tests.

In 1925 Gifford [7] reported observations based on a study of 86 patients. Of these, 12.6 per cent gave positive cutaneous reactions to lens antigen. Of patients reacting positively, 6 showed rather marked postoperative intraocular inflammatory reactions which, the author remarked, "may well be interpreted as being due to their sensitization to lens protein." Gifford found suspensions of normal lens protein toxic to rabbits and cataractous lens more toxic. He concluded:

> While endophthalmitis phaco-anaphylactica, in the sense of Verhoeff and Lemoine, undoubtedly does occur, a huge number of reactions to lens substance cannot be explained as anaphylactic, and perhaps a majority of such reactions are due to the toxicity of lens matter itself. Hence a better name for the whole group of reactions is that of Straub, endophthalmitis phacogenetica.

Braun [8] and others have opposed the anaphylactic theory and have offered evidence tending to support the contention that lens substance is toxic, but Burky and Woods [9] have found that suspensions of lens protein produced under aseptic precautions are practically devoid of toxicity.

While the anaphylactic explanation of this type of postoperative and post-traumatic inflammation had received rather wide acceptance, no convincing confirmatory experimental evidence was brought forward until 1934.

---

5. Verhoeff, F. H., cited by Burky, E. L.: Experimental Endophthalmitis Phaco-Anaphylactica in Rabbits, Arch. Ophth. **12**:536 (Oct.) 1934.

6. Lemoine, A. N., and MacDonald, A. E.: Arch. Ophth. **53**:101, 1924.

7. Gifford, S. R.: Allergic and Toxic Properties of Lens Protein, J. A. M. A. **85**:351 (Aug. 1) 1925.

8. Braun, R.: Arch. f. Augenh. **106**:99, 1932.

9. Burky, E. L., and Woods, A. G.: Lens Extract: Its Preparation and Clinical Use, Arch. Ophth. **6**:548 (Oct.) 1931.

It should be noted that Uhlenhuth [10] in 1903 discovered a new biologic principle, namely, antigenic organ specificity, by showing that the lens protein of all vertebrates is antigenically unlike other tissue proteins, whereas there is almost complete lack of species specificity; i. e., the lens protein of all of the higher animals is antigenically similar. While many reports have confirmed Uhlenhuth's observations, it has been held by some that this theory of specificity has not been proved beyond doubt. The doubt arose chiefly through the extreme difficulty in rendering experimental animals hypersensitive to lens protein.

Burky [11] had noticed that in rabbits given intracutaneous injections of staphylococcus toxin there developed not only an antitoxin for the toxin but a hypersensitivity to the beef broth in which the toxin had been prepared. It occurred to him that if such a poor antigen as beef broth could be made active by the action of staphylococcus toxin, a similar effect might be produced by combining the toxin with lens substance. This proved to be the case. By repeated intracutaneous injections of a mixture of beef lens protein, staphylococcus toxin and broth, Burky succeeded in rendering rabbits highly sensitive to beef lens substance and therefore to their own lens protein. When a precipitin reaction to lens protein was obtained in high dilutions of the blood serum, the animals were subjected to a minor degree of trauma to the lens. A severe intraocular inflammation ensued, so severe that the injured eyes were enucleated to prevent their rupture, and, indeed, one did rupture during enucleation. The histologic picture in these eyes closely resembled the lesion of endophthalmitis phacoanaphylactica in man. The experiments were ingeniously devised and amply controlled. Burky was able by continued injections of lens extract and staphylococcus toxin to reduce and finally to eliminate a preexisting cutaneous reactivity in other rabbits. When the lenses were then needled no intraocular inflammation developed.

Burky and Henton [12] have since shown that in man also cutaneous sensitivity to lens can be eliminated by suitable intracutaneous injections of lens antigen and staphylococcus toxin. "It is probable," they stated. "that ocular sensitivity to lens is also eliminated or reduced."

These experiments, it would seem, have solved the enigma of endophthalmitis phacoanaphylactica. They have refocused attention on the lens as a potential source of a dangerous antigen. They have indicated a practical means of prophylaxis and therapy through desensitization.

Now that the concept advanced by Verhoeff and Lemoine has at last been given strong experimental support, the name they suggested,

10. Uhlenhuth, P., in Festschrift zum sechzigsten Geburtstage von Robert Koch, Jena, Gustav Fischer, 1903, p. 49.

11. Burky, E. L.: J. Immunol. **25**:419, 1933; Experimental Endophthalmitis Phaco-Anaphylactica in Rabbits, Arch. Ophth. **12**:536 (Oct.) 1934.

12. Burky, E. L., and Henton, H. C.: Am. J. Ophth. **19**:782, 1936.

endophthalmitis phacoanaphylactica, will probably come into more general use. Even recent textbooks of ophthalmology give little consideration to this disease. Wolff [13] in his "Pathology of the Eye" (1935) made no mention of such a lesion under any designation. Von Szily [14] in the "Handbuch der speziellen pathologischen Anatomie und Histologie," by Henke and Lubarsch, reviewed briefly the various theories of etiology and concluded that the allergic nature of the lesion has not been proved. He endorsed the older toxic theory and the name associated with it, i. e., endophthalmitis phacogenetica. Von Szily made no reference to Burky's work, although it had been reported three years before the publication of this volume in the Henke and Lubarsch series. The lesion, however, even before Burky's contributions, had come to be recognized by many as a fairly constant and apparently specific histologic entity. The classic histologic description furnished by Verhoeff and Lemoine has never, to my knowledge, been improved on, although one encounters examples of the disease in which there is more or less departure from the picture observed in their cases.

Probably because only the eyes that run an unfavorable postoperative or post-traumatic course come under the observation of the pathologist in the laboratory, I have gained the impression that endophthalmitis phacoanaphylactica is an important disease and not nearly as infrequent a cause of destruction of the eye as one might infer from its treatment in the textbooks. Histologic studies have led to the impression that Verhoeff and Lemoine were right when they suggested that minor degrees of sensitization to lens antigen probably also occur but that one is not able to identify such cases with certainty either clinically or histologically. On the basis of histologic evidence supported by clinical observations it would further appear that in occasional instances endophthalmitis phacoanaphylactica precedes and is in some way causally related to sympathetic ophthalmia. If this is true, the phacoanaphylactic inflammation not only endangers the vision of an injured eye but as a potential precursor of sympathetic ophthalmia may lead to destruction of both eyes. Not infrequently, in an enucleated eye the granulomatous uveal lesion of sympathetic ophthalmia is accompanied by a reaction about a disintegrating lens suggestive of the endophthalmitis described by Verhoeff and Lemoine. Occasionally there is an outspoken combination of these two histologic entities along with a clinical history to support the interpretation that a postoperative or post-traumatic reaction to lens protein has led to the development of sympathetic

13. Wolff, E.: Pathology of the Eye, Philadelphia, P. Blakiston's Son & Co., 1935.

14. von Szily, A., in Henke, F., and Lubarsch, O.: Handbuch der speziellen pathologischen Anatomie und Histologie, Berlin, Julius Springer, 1937, vol. 11, pt. 3, p. 29.

ophthalmia, the damaged lens having served as a culture medium for infection, as a source of a toxic irritant or as an antigen to which the ocular tissues had previously become sensitized.

In the literature on sympathetic ophthalmia almost no consideration has been given to the lens. The "allergic theory" was based on the idea that sensitization to uveal pigment either is the immediate cause or in some important respect is involved in the causation of this apparently specific disease. Behrens and Bogart in a recent article stated: "We believe that hypersensitiveness to uveal pigment *or other tissue* [author's italics] of the eye may play a role in the development of sympathetic ophthalmia." Sensitization to lens protein, to the best of my knowledge, has never been thought to be of etiologic significance, although occasional cases are recorded in which the patient reacted positively to cutaneous tests with lens antigen.

In several of the older ophthalmologic treatises, however, there are found references to an indirect or remote relation between injury to the lens and sympathetic ophthalmia. Randolph [15] in 1898, speaking of perforating wounds in connection with sympathetic ophthalmia, observed that "traumatic cataract . . . is to be regarded as an unfortunate complication. As soon as the lens capsule is ruptured the lens swells up and presses against the wounded iris and ciliary body, and acts as a constant irritant."

In 1917 H. Gifford [16] wrote:

> It is evident that some operative wounds furnish ideal conditions for the production of sympathetic ophthalmia, particularly operations for cataract; and it is not surprising that a number of cases of the disease have been reported after cataract expressions and other operations involving the iris. Whether the determining factor in these cataract cases is merely the inclusion of the iris in the wound (including also the infection), or whether remaining cortex may contribute to the sympathetic ophthalmia either by furnishing food for infection or by favoring infection through pressure or chemical influence is worth considering. The writer has seen one case in which, without any iris prolapse, the retention of a very small hard nucleus was followed by the worst case of sympathetic ophthalmia he has ever seen.

Again quoting Randolph: "It may be emphasized that whatever can cause an iridocyclitis in one eye can indirectly bring about sympathetic inflammation in the other." Restated, to conform with modern concepts, Randolph's dictum might be expressed as follows: Whatever can cause iridocyclitis in one eye can indirectly bring about the specific lesion of sympathetic ophthalmia, which has been shown to be the same in each eye. This statement is in line with the aphorism that any factor preventing prompt healing of a penetrating wound of the eye may,

15. Randolph, R. L., in Norris, W. F., and Oliver, C. A.: System of Diseases of the Eye, Philadelphia, J. B. Lippincott Company, 1898, p. 721.

16. Gifford, H., in Wood, C. A.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1920, vol. 16, p. 12385.

indirectly, lead to sympathetic ophthalmia. In this respect, at least, endophthalmitis incident to injury of the lens would seem to be of importance. If the allergic character of such a reaction is conceded, one need not exclude from consideration the possible factors of infection and toxicity of lens substance. Indeed, it may well be that local infection at the site of injury can furnish toxic adjuvant substances which augment the antigenic properties of the lens protein, as did the staphylococcus toxin in Burky's experiments. One might further postulate that sensitization to uveal pigment, which is apparently an essential factor in the development of sympathetic ophthalmia, may readily occur in the presence of a destructive uveal lesion initiated by hypersensitivity to another antigen, namely, lens protein.

Enucleated eyes that show the combined lesions referred to here have been from patients whose histories suggest that a reaction to lens protein preceded the development of sympathetic ophthalmia. Usually there has been previous surgical or accidental injury of one lens or of both lenses. A subsequent traumatization, such as needling of an after-cataract, has been followed by an intractable iridocyclitis. If enucleated as a prophylactic measure, the eye usually presents only the characteristic picture of endophthalmitis phacoanaphylactica. If the eye is enucleated because of the onset of inflammation in the second eye, the combined features of these two diseases may be seen.

REPORT OF CASES

The following short summaries of clinical cases with a description of an enucleated eye from each of the patients are illustrative of the more outspoken examples of these combined lesions.

CASE 1.—C. M., a white man aged 61, was admitted to the hospital for extraction of a mature senile cataract of the left eye. A preliminary iridectomy was followed by iridocyclitis, which persisted for four weeks. The eye was still acutely inflamed when signs of sympathetic inflammation appeared in the right eye. The exciting eye was promptly enucleated. The inflammation in the sympathizing eye gradually subsided, and the patient was discharged, improved, thirteen days after the enucleation.

The enucleated eye was of normal size and proportions. The cornea had been rendered opaque by the action of a fixative. The scar of a surgical incision was seen at the limbus superiorly. Windows were cut in the sclera in the vertical plane, and the eye was embedded in pyroxylin. Multiple sections were made close to the vertical meridian (fig. 1).

On microscopic examination the corneal wound was seen to gap slightly and some iris tissue, folds of lens capsule and fairly abundant granulation tissue were found interposed between the lips of the wound and streaming out beneath the conjunctiva. The prolapsed iris tissue was heavily infiltrated with lymphocytes and plasma cells. Numerous collections of epithelioid cells and pigment-laden giant cells lay among the round cells. The capsule of the lens had been ruptured, and a mass of newly formed granulation tissue extended between the lens and the structures in the region of the operative wound. The inferior portion of the iris

was adherent to the lens capsule, and a thin membrane stretched from the pupillary margin across the surface of the lens to unite with the granulation tissue in the operative field. There was rather heavy cellular infiltration in the stroma of this portion of the iris. The cells were chiefly lymphocytes and plasma cells but included also moderate numbers of polymorphonuclear leukocytes, occasional eosinophils and many "clump" cells. A layer of inflammatory cells covered the anterior surface of the iris and extended onto the posterior surface of the cornea. Large phagocytic cells, laden with melanin, were conspicuous in this layer. Between the pigmented epithelial layer and the sphincter and dilator muscle layers rather abundant granulation tissue and cellular exudate were interposed. Here epithelioid cells and large numbers of giant cells were intermingled with leukocytes, but no discrete epithelioid nodules were seen. The angle of the anterior chamber was

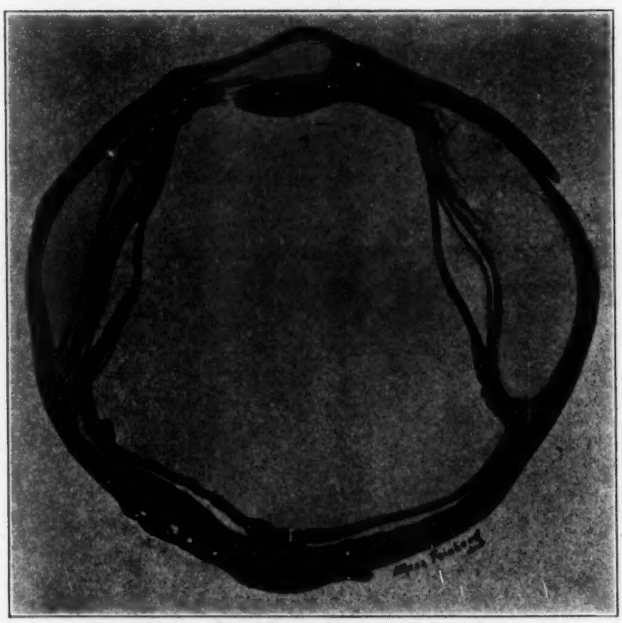


Fig. 1 (case 1).—Drawing of a meridional section of the eye. The operative wound, with incarcerated iris and lens capsule, is shown. The inflammatory reaction about the disintegrating lens substance is clearly seen. There is detachment of the retina, ciliary body and part of the choroid. Dense masses of infiltrating cells and pale epithelioid nodules are most conspicuous in the choroid posteriorly.

closed inferiorly by a broad anterior synechia. The ciliary body was edematous and partially detached by albuminous fluid. It was hyperemic, and the vessels showed local leukocytosis. There was extensive diffuse cellular infiltration of about the same cellular character as that in the iris stroma. In the flat portion dense nodular collections of round cells were found, and occasional epithelioid nodules lay within these collections. The infiltration here was most marked in the vascular layer. Over the ciliary portion of the ciliary body the pigmented and nonpigmented epithelial layers were separated by exudate, and many epithelioid cells and giant cells were scattered among clusters of disorganized epithelial cells. Several nodular, cellular masses were found protruding beneath the ciliary epi-

thelium and the retinal layers in the region of the ora serrata (Dálen's nodules). The retina was partially detached by hemorrhage and albuminous fluid. There were also edema, small focal hemorrhages and a moderate degree of sclerosis of the retinal vessels. In the choroid the most characteristic features of sympathetic ophthalmia were found. In the outer and middle thirds there were large masses of round cells, and in these areas epithelioid nodules were prominent (fig. 2). They lay, for the most part, close to the outer surface. Occasional giant cells

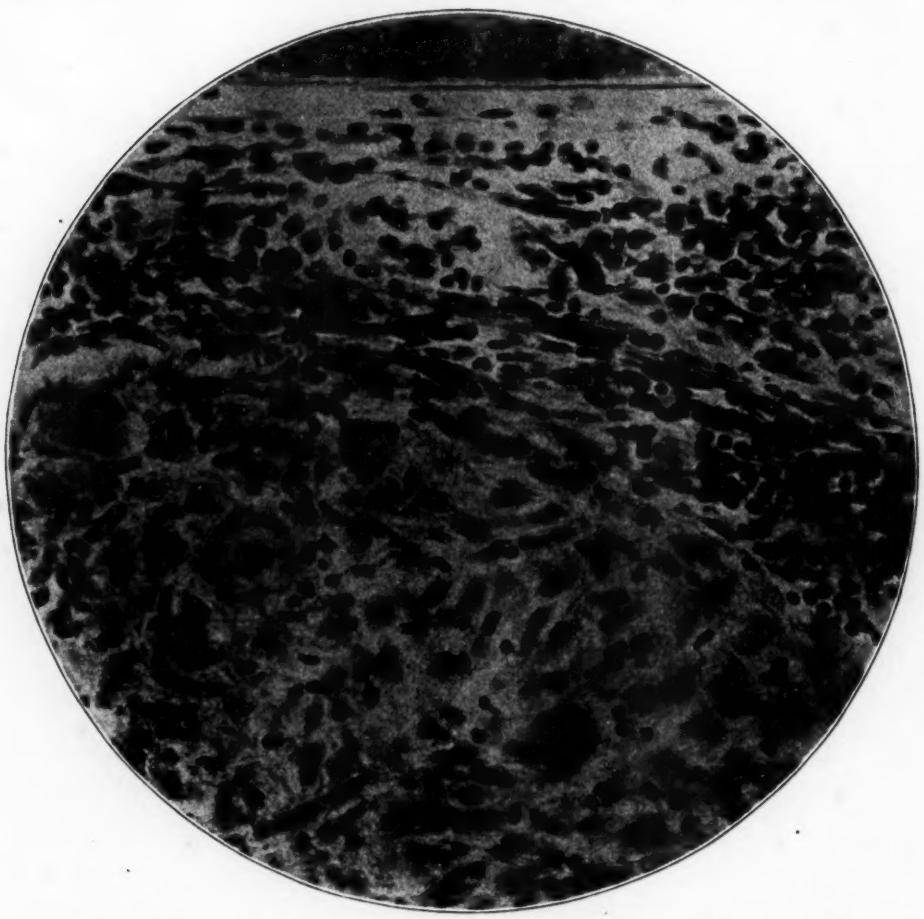


Fig. 2 (case 1).—Photomicrograph of one of the epithelioid nodules in the choroid. The smoky tinge of the cytoplasm of the larger cells is due to phagocytized particles of pigment. The small cells surrounding the nodule are chiefly lymphocytes and plasma cells. Note the absence of involvement of the choriocapillaris. The pigment epithelium of the retina is seen at the top of the field.

were seen in these nodules. Here, as in the other portions of the uvea, the epithelioid cells contained fine granules of melanin, while many of the giant cells appeared as dense black clumps of pigment. There was partial detachment of the choroid in the equatorial zone. The uveal tissue, surrounding the blood vessels and nerves

in their course through the emissaria of the sclera, showed an infiltration similar to that of the choroid and contained also nodular epithelioid structures. Otherwise the sclera was essentially normal. There was no cupping of the optic disk, and the lamina cribrosa was not excessively bowed. Several filamentous strands of connective tissue streamed into the vitreous from the disk. These were festooned with lymphocytes and large mononuclear phagocytic cells. The vessels in the optic nerve showed a moderate degree of sclerosis. The meninges covering the stump of the nerve appeared normal. In the nerve itself there was slight infiltration with round cells.

Of particular interest was the reaction in and about the site of rupture of the lens capsule. The lens was cataractous, both the cortical and the nuclear structures showing advanced degenerative changes. It had been reduced considerably in bulk and flattened anteroposteriorly. Wandering cells had invaded the space between folds of the ruptured capsule and had insinuated themselves among the disintegrating lens fibers. The cells consisted chiefly of epithelioid cells, but there was also an admixture of lymphocytes and polymorphonuclear leukocytes. The reaction in this region closely resembled that described by Verhoeff and Lemoine. The lesions in the uvea included all of the features commonly regarded as constituting the typical picture of sympathetic ophthalmia.

Comment.—In this case both the reaction about the disintegrating lens substance and the lesion of sympathetic ophthalmia were of recent development. If the former is regarded as an allergic reaction, a preexisting sensitization to lens protein must be assumed even though no history of injury or previous operation was elicited.

Case 2.—F. C., a white man aged 58, was admitted to the hospital with a mature senile cataract in the right eye and an immature cataract in the left eye. A preliminary iridectomy was performed on the right eye, the lens capsule being injured during the procedure. Some lens matter escaped into the anterior chamber, but no untoward reaction ensued. Extraction two months later yielded satisfactory results.

One year later iridectomy was performed on the left eye, and two months after that an extraction was done. Some cortical material escaped into the anterior chamber but was being absorbed when the patient was discharged. He returned to the hospital four months later with a soft left eye which had been the seat of a persistent low grade of inflammation from the time of operation. The eye was then enucleated. At that time no sympathizing process was apparent, but when the patient visited the clinic two months later the right eye was found to be soft, and there was faulty perception of light. The diagnosis of phthisis bulbi was made.

The enucleated left eye showed a small flat opaque cornea but was normal in size and general contour. Windows cut in the vertical plane revealed a thick choroidal layer. The retina appeared to be in place. The vitreous was semiopaque and had been coagulated by a fixative. Microscopic sections were cut in pyroxylin, and those close to the vertical meridian were selected for study.

The scar of an operative wound was seen at the limbus superiorly. The cornea was edematous and was irregular in thickness. The stroma was scarred and moderately vascularized. The subconjunctival tissue contained numerous lympho-

cytes and plasma cells. The anterior chamber was almost entirely obliterated, the iris being adherent to the cornea inferiorly and a granulomatous mass extending from the lower border of the pupil to the angle and ciliary body superiorly. A remnant of the lens surrounded by fragments of the capsule lay in the center of this mass. Disintegrating lens fibers were being invaded by leukocytes, among which polymorphonuclears predominated. These cells formed a fairly broad zone adjacent to the lens material. Peripheral to this zone lay a border of epithelioid

Fig. 3 (case 2).—The phacoanaphylactic reaction about a mass of disintegrating lens material. Lens fibers are seen at the bottom of the field. A fragment of capsule is shown to the left. Leukocytes form a mantle about the lens substance. A fringelike bank of epithelioid cells, a zone of densely packed round cells and scarred corneal tissue appear from below upward in the order named.

cells arranged in palisade fashion (fig. 3), while still farther out fibroblastic and vascular proliferation had produced an encapsulating layer.

The remainder of the picture was typical of the moderately advanced lesion of sympathetic ophthalmia. This granulomatous process was limited to the uvea

except in the ciliary body and iris, where it had extended inward among the ciliary processes and into the posterior chamber. Pigmented giant cells were numerous in the ciliary body (fig. 4). The retina was slightly detached by albuminous fluid. The choroid and ciliary body also showed partial detachment. The sclera showed a minimal degree of involvement, consisting of round cell infiltration about the perforating vessels and nerves.

Fig. 4 (case 2).—A portion of the ciliary body. The pigmented and nonpigmented epithelial layers are separated and disorganized by invasion of granulomatous tissue. The epithelioid cells, pigmented giant cells and various leukocytes form a characteristic picture of sympathetic ophthalmia.

Comment.—In this instance the phacoanaphylactic reaction about the disintegrating lens fibers was of a more severe type than in the preceding case. The lesion of sympathetic ophthalmia was in a more advanced stage of development. A history of multiple injuries to one

or both of the lenses, as in this case, should suggest the possibility of sensitization to lens protein. Cutaneous tests would presumably have revealed such a condition.

CASE 3.—J. R., a white man aged 53, received a perforating wound of the right eye by being stuck with a knife. The wound extended from the center of the cornea to the limbus nasally. Lens material was visible in the pupil. A

Fig. 5 (case 3).—The phacoanaphylactic reaction about remnants of lens material.

traumatic coloboma of the iris was noted on the nasal side. Twenty-six days after the injury a combined extraction was performed. There was difficulty in expressing the lens, and a considerable amount of cortex was left in the eye. The patient was discharged two months after the injury with some persisting inflammatory reaction. Lens material was still visible behind the laceration. Three months from the date of injury he returned to the hospital with both eyes inflamed, and the injured right eye was then enucleated. The inflammation in the sympathizing

eye gradually subsided during a period of forty days. Vision could then be corrected to 20/70. Some precipitates were still present on the posterior surface of the cornea, and there was some exudate in the vitreous.

The enucleated eye showed a flattened and scarred cornea but was otherwise normal in size and shape. It was embedded in pyroxylin and sectioned along the horizontal meridian. Healed scars were seen near the center of the cornea and at the limbus. Some squamous epithelium had grown into the corneal stromal layer at the site of the central scar. The anterior chamber was obliterated by adhesion between the cornea and the iris temporally and by a granulomatous mass containing remnants of lens material and capsular fragments. The lens substance was surrounded by a zone of acute inflammatory exudate which, in turn, was

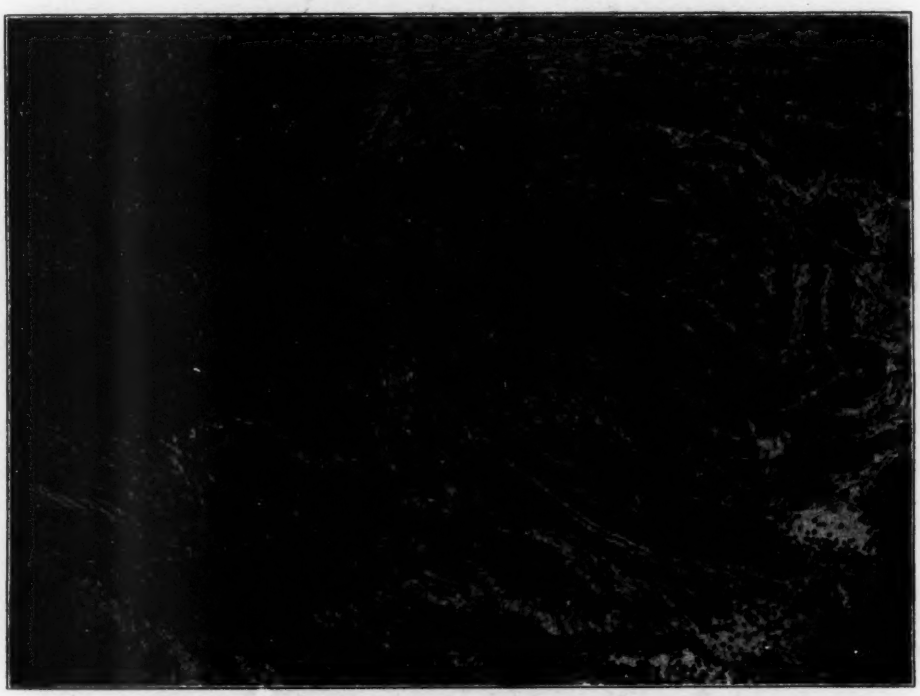


Fig. 6 (case 3).—Folds of epithelium in the inflamed ciliary body being drawn forward (toward the left) by bands of connective tissue at the periphery of the lesion shown in figure 5. The only feature in this field suggestive of sympathetic ophthalmia is the row of pigmented epithelioid and giant cells along the right upper border of the picture.

enclosed in a mantle of granulomatous tissue containing abundant epithelioid cells (fig. 5). This reaction appeared to be of rather long standing. In the ciliary body there were diffuse cellular infiltration and marked edema. The epithelial layers of the ciliary body were distorted, and epithelioid nodules containing pigmented giant cells were occasionally seen (fig. 6). Near the ora serrata a number of Dálen's nodules were found. The choroid contained many dense masses of lymphocytes and plasma cells with a few small clusters of epithelioid cells

(fig. 7).. The epithelioid cells contained particles of uveal pigment, as did those in the other structures. The retina, sclera and optic nerve showed only minor changes.

Comment.—From the histologic picture one might conclude that the phacoanaphylactic reaction antedated the development of the features of sympathetic ophthalmia by a considerable period of time. The latter

Fig. 7 (case 3).—One of the early nodules of lymphocytes and plasma cells found in the choroid. One small cluster of epithelioid cells is seen toward the right near the outer margin of the nodule.

were obviously early changes. In this instance, and in the preceding cases as well, it is impossible to determine how much of the diffuse cellular infiltration in the uvea and of the exudation into the chambers should be attributed to each of the two disease entities.

COMMENT

Since it has been shown that reactions to lens substance occur only among the 8 per cent of patients who react positively to intradermal injections of lens antigen, it would seem that failure to discover the sensitive patient prior to operation is a serious error. This can be avoided by performing routine tests on all candidates for operation for cataract, or at least on all those in whom the lens has been subjected to previous accidental or surgical trauma.

When sensitivity to lens protein is encountered desensitization may be undertaken with greater expectation of success now that an augmented antigen is available. Berens and Bogart [17] employed the method of desensitization advocated by Burky and Henton in 5 patients who had lost one eye from postoperative inflammation and had been found to be hypersensitive to lens protein. According to them the patients "were desensitized before the second eye was operated upon. The second operations were all successful and were followed by only slight reaction in spite of the fact that the capsule was ruptured in each case." They added that "desensitization before operation and during the period of convalescence seems to be of some benefit." That the same activated antigen may prove useful in the therapy of inflammatory conditions attributable to sensitivity to lens protein is indicated by a recent clinical experience to be reported elsewhere.

If it is true that in some cases of sympathetic ophthalmia sensitization to lens protein is an important etiologic factor, then prevention and cure of phacoanaphylactic inflammation will tend to reduce the incidence of sympathetic ophthalmia.

SUMMARY AND CONCLUSIONS

A type of intraocular inflammatory reaction that occasionally follows accidental, surgical or spontaneous rupture of the capsule of the crystalline lens has been discussed from the standpoint of causation. Emphasis has been placed on Burky's experimental reproduction of the lesion in rabbits sensitized to an antigen of lens protein augmented by staphylococcus toxin. Strong support of the allergic theory in contradistinction to the infectious and toxic theories of causation has been furnished by this work, and an effective means of desensitization has been developed. The importance of this disease entity, referred to as endophthalmitis phacoanaphylactica by the proponents of the allergic theory, has been stressed.

17. Berens, C., and Bogart, D. W.: Am. J. Surg. **42**:39, 1938.

The hypothesis has been advanced that this disease is occasionally a precursor of sympathetic ophthalmia. Brief clinical abstracts and histologic changes in 3 illustrative cases have been presented in support of this contention. In each instance endophthalmitis phacoanaphylactica seemed causally related to an ensuing sympathetic ophthalmia.

Prevention and, possibly, cure of phacoanaphylactic reactions through desensitization may result in a reduction of the incidence of sympathetic ophthalmia, especially of sympathetic ophthalmia incident to cataract extraction.

ANGIOMATOSIS RETINAE (HIPPEL'S DISEASE)

REPORT OF A CASE IN WHICH ROENTGEN THERAPY WAS USED IN AN EARLY STAGE

FREDERICK C. CORDES, M.D.
AND
MICHAEL J. HOGAN, M.D.
SAN FRANCISCO

Since von Hippel [1] in 1904 first published his account of angiomatosis retinae as a separate entity, approximately 135 cases have been reported, so that the condition is now well recognized and understood. This is especially true since Lindau's [2] classic work demonstrated that the condition is often part of an angiomatosis of the central nervous system. Little, however, has been said regarding therapy, and it appears as though it has been assumed that Wood's [3] statement in 1892 that treatment entirely failed to arrest the condition must necessarily apply to all cases. The report presented here seems to us to justify a brief review of the literature with particular emphasis on an attempt to evaluate radiation therapy in these cases.

In order to realize that any type of therapy must have a limited place in the treatment of this disease, it is necessary that the entire picture of angiomatosis retinae be understood.

HISTORICAL SURVEY

The first description of angiomatosis retinae in the literature is by E. Fuchs,[4] who in 1882 described it under the title of "Aneurysma arteriovenosum traumaticum." There was an immense dilatation of a branch of the central artery and its corresponding vein with a red globular retinal mass and some retinal exudate. The second case was recorded by Wood [3] and presented before the Ophthalmological Society of the United Kingdom in 1892. The condition was described as an immense dilatation of retinal vessels with detachment of the retina at the outer side. The excellent colored illustration accompanying the report

---

From the Division of Ophthalmology, University of California Medical School.

President's address, Pacific Coast Oto-Ophthalmological Society, San Francisco, June 19, 1939.

1. von Hippel, E.: Arch. f. Ophth. **59**:83, 1904.
2. Lindau, A.: Acta ophth. **4**:193, 1927.
3. Wood, D.: Tr. Ophth. Soc. U. Kingdom **12**:143, 1892.
4. Fuchs, E.: Arch. f. Augenh. **11**:440, 1882.

leaves no doubt as to the diagnosis. In 1894 Collins [5] reported the third case, the patient being a sister of Wood's patient. Lloyd [6] in his bibliography includes 7 additional cases under various titles that were described in the literature before 1902. In 1902 Leplat [7] recorded a case under the title of congenital arteriovenous aneurysm.

Von Hippel [1] expressed the belief that the condition in these cases represented different interpretations of the same clinical picture and that it was a low grade chronic inflammatory process accompanied by local changes in the arteries and veins of the retina. He suggested tuberculosis as a possible etiologic factor and stated that the condition had not been studied pathologically. He was not at the time aware of the fact that Treacher Collins [5] in 1894 reported on the microscopic changes in the eyes of Wood's patient and in the eyes of the patient's sister.

After von Hippel's description of the disease as a clinical entity, reports of cases appeared in the literature from time to time. An excellent bibliography of these cases is found at the end of Bedell's [8] article. In a recent report [9] it was stated that Scarlett [10] in 1925 was the first to report a case of angiomatosis retinae in this country. A search of the literature, however, reveals that in 1904 Millikan [11] reported a typical case accompanied by excellent illustrations under the title "An Unusual Case of Retinal Disease." In 1913 Bane [12] reported a case of typical angiomatosis retinae that he had seen in 1895.

OCULAR MANIFESTATIONS AND COURSE OF DISEASE

According to Bedell,[8] the earliest photographic sign is fulness of retinal veins, as though a constricting band impeded the venous outflow. Ditroi [13] stated that the first ophthalmoscopic change is a fan-shaped anastomosis between one branch of the central artery and the central vein, which is the beginning of the tumor formation.

From this rete mirabile a berry-like reddish-colored mass develops that is sharply demarcated from the surrounding area and is supplied by an artery and vein. Characteristically, both vessels develop into wormlike enlarged stems carrying dark blood, and in a short time it is

5. Collins, E. T.: Tr. Ophth. Soc. U. Kingdom **14**:144, 1894.
6. Lloyd, R.: Am. J. Ophth. **11**:599, 1928.
7. Leplat, G.: Ann. d'ocul. **127**:224, 1902.
8. Bedell, A.: Am. J. Ophth. **14**:389, 1931.
9. McDonald, R., and Lippincott, S. W.: Angiomatosis Retinae: Report of a Case with Pathologic Study of the Enucleated Eye, Arch. Ophth. **20**:958 (Dec.) 1938.
10. Scarlett, H.: Arch. Ophth. **54**:183, 1925.
11. Millikan, B. L.: Arch. Ophth. **33**:471, 1904.
12. Bane, W. M.: Ann. Ophth. **22**:400, 1913.
13. Ditroi, G.: Klin. Monatsbl. f. Augenh. **59**:43, 1917.

impossible to differentiate between the artery and the vein. The retina is slightly elevated surrounding the tumor. Around the macula and disk shiny white spots of exudate make their appearance, which at first are pinhead in size and later become confluent. At times this exudate is arranged as a stellate figure in the macula. Frequently there are also collections of exudate along the vessels. A little later a globular detachment of the retina appears surrounding the enlarged tumor mass. In this stage the exudate increases in amount and assumes a yellowish color. The condition progresses until a massive detachment of the retina, which protrudes into the vitreous, is present. Glistening yellowish white spots of exudate are present over the entire fundus during this stage. The vessels leading to the tumor become markedly enlarged, the disk atrophic and the eye amaurotic.

It is noteworthy that frequently these vascular tumors are multiple either in the beginning or later in the course of the disease. They retain their globular appearance only in the early stages and later become more tumor-like, with nobs and irregularities. The white or yellowish white circumscribed areas of exudate may be extensive over the retina and may produce a picture similar to that of retinitis circinata or retinitis albuminurica. These areas of degeneration, however, are usually slightly elevated, a condition not found in the previously mentioned retinitis. In addition, they are often surrounded by a ring of dark red due to the fact that the proliferating glial tissue has absorbed some pigment from the degenerating pigment layer. Hemorrhages may also occur into the retina and vitreous and at times may be severe. Detachment of the retina is always present in cases in which the condition is advanced, usually developing from the periphery and giving the impression of being semisolid. In some instances transillumination gives the impression of a solid detachment and has led to the diagnosis of retinoblastoma or other intraocular tumors. The complete detachment of the retina, which often has the appearance as though it lay over or was permeated by coagulated milk, completes the picture in the late stages.

Finally iridocyclitis develops, complicated by secondary glaucoma and eventual opacification of the lens. Treacher Collins [5] found in his second case that a plexus of capillaries similar in structure to the retinal tumor had penetrated the cornea, while von Hippel [14] found in 1 case penetration of the choroid. Aust [15] and others observed that choked disk is seen in certain of these cases, which is readily understood now that it is known that tumors of the brain also occur in a large percentage. However, as Bedell,[8] Guzmann,[16] Tresling [17] and others have pointed out, at

14. von Hippel, E.: Arch. f. Ophth. **79**:350, 1911.
15. Aust, O.: Ztschr. f. Augenh. **50**:305, 1923.
16. Guzmann, E.: Arch. f. Ophth. **89**:323, 1915.
17. Tresling, J.: Klin. Monatsbl. f. Augenh. **64**:306, 1920.

primary examination a picture of choked disk with swelling and macular exudate may be presented, so that careful differentiation may be necessary.

NEURO-OPHTHALMOLOGIC PATHOLOGIC PICTURE

It seems best to consider the pathologic picture of the disease as a whole before discussing in detail the microscopic pathologic picture of the ocular lesions.

Schieck [18] pointed out that various terms, such as gliosis retinae diffusa, angiogliosis retinae, angiomatosis retinae and hyperplastic hemangioma, resulted from the fact that the pathologic picture of the disease was not understood until Lindau was able to associate the various factors. The first pathologic report of a case has been credited to Czermak,[19] who in 1905 recorded his findings; he did not realize at the time that Treacher Collins [5] had reported a case in 1894 and described the condition as a "peculiar vascular new-growth." Czermak reported that it was a true vessel tumor of the inner layers of the retina, with the smaller and smallest branches of the central vessels showing a thickening of the vessel wall and enlargement of the lumen. He expressed the belief that as a result of budding new branches developed a vascular coil or glomerulus. Following this, the surrounding retina degenerated and was displaced by the tumor mass, in which there was a secondary proliferation of glial tissue. He found that the glial masses contained cavities filled with coagulated material, while in the subretinal area there were congealed exudates as well as disintegrated hemorrhages. Von Hippel [14] in his case also found an angiomatous growth embedded in glial tissue. In certain areas the tumor had a peculiar light appearance, and in these areas lay many round, sharply demarcated bodies the size of an erythrocyte which were included in the protoplasm of large cells. These were closely packed together and had a large round cystlike nucleus with abundant paraplastic substance. Von Hippel regarded these as derivatives of glia. The extension of vessel buds into the vitreous and other areas further suggested angiomatosis.

Meller,[20] Guzmann [16] and others expressed the belief that the gliosis and not the vessel proliferation was the primary factor in the production of tumor. Meller stated that the growth was primarily gliomatous and that angiomatous nodules were a reaction to the glial growth. He based his opinion on the fact that in true angiomas there is little gliosis. Gins-

18. Schieck, F., in Henke, F., and Lubarsch, O.: Handbuch der speciellen pathologischen Anatomie und Histologie, Berlin, Julius Springer, 1928, vol. 11, pt. 1, p. 681.

19. Czermak, W.: Ber. ü. d. Versamml. d. ophth. Gesellsch. **32**:184, 1906.

20. Meller, J.: Arch. f. Ophth. **85**:255, 1913.

21. Ginsberg, S., and Spiro, G.: Arch. f. Ophth. **88**:44, 1914.

22. Bergmeister, G.: Arch. f. Ophth. **105**:1, 1921.

berg and Spiro [21] and Bergmeister [22] took the middle ground in the argument. They stated that there was simultaneous capillary and glial proliferation but that it was of a blastomatous nature judging from the glial tissue found. Brandt,[23] in sections from an eye with recent involvement, was able to demonstrate an absence of glial tissue and to show that the tumor was primarily a blood vessel tumor. This agreed with the earlier findings of Gamper,[24] who found no new glia within the growth itself and only a small amount between the larger vessels. Lindau's [2] second case also demonstrated angiomatosis without glial proliferation. Von Hippel [25] during this time continued to hold his original opinion. In 1921 Brandt [23] called attention to the fact that in 10 per cent of 40 collected cases there were tumors of the brains, which he called endothelioma. Regarding the angiomas of the retina, he emphasized correctly that the lesion was a true tumor which differed from other angiomas of the body in that it did not begin to show clinical evidence of its presence, on the average, until the third decade. In 1922 Berblinger [26] made a critical survey of the pathologic process and concluded that the condition was primarily a proliferation of capillaries with secondary gliosis but admitted that in the later stages of the process the glial proliferation assumes blastomatous characteristics that give the impression of angiogliomatosis.

It was the classic work of Lindau [2] in 1927 that clarified the picture, when, among other things, he confirmed von Hippel's opinion that the condition is primarily an angiomatosis. He demonstrated that the lesions in the brain consist of angiomatous tumors in that part of the embryonic brain from which the medulla oblongata and cerebellum are developed and that these tumors have a tendency toward cyst formation in the nerve substance. These processes in the retina and brain can be summarized as angiomatosis of the central nervous system. The disease shows coordinated malformation and tumors, such as pancreatic cysts and hypernephroma, a complex that reminds one of tuberous sclerosis. The term angioplastic tumors unites the different opinions of von Hippel, Brandt and others and explains the variations of these tumors. Lindau expressed the belief that these tumors could be classified as nevi of the central nervous system and that in long-standing retinal tumors there was a secondary glial reaction not present in the original glial picture. He also concluded that these angioplastic tumors were identical with the perithelioma of Cushing. He further expressed the belief that the opinion of Cushing that the area postrema in the caudal portion of the fourth ventricle forms the matrix for the angioma is in part

23. Brandt, R.: Arch. f. Ophth. **106**:127, 1921.
24. Gamper, F.: Klin. Monatsbl. f. Augenh. **61**:525, 1918.
25. von Hippel, E.: Arch. f. Ophth. **95**:173, 1918.
26. Berblinger, W.: Arch. f. Ophth. **110**:395, 1922.

supported by the localization of the tumors and in part by a certain relation histologically between the area postrema and the angioplastic tumors. Lindau's classification was accepted by von Hippel.[27] In 1928 Cushing and Bailey [28] confirmed Lindau's work and reported the first case of Lindau's disease in which a histologic diagnosis had been made during life. In 1932 Atkinson [29] reported a second case of angiomatosis retinae and a cerebellar cyst in which the condition was diagnosed during life. Of interest is the fact that four years after removal of the cerebellar cyst the patient wrote that he was working and felt well. The right eye, however, was amaurotic.

OCULAR MICROSCOPIC PATHOLOGIC PICTURE

Microscopically, the growth is composed of a plexus of thin-walled capillary blood vessels situated in the retina. At times there may be small solid masses of endothelial cells. The cells between the vessels show few mitoses, while the feeding vessels are greatly dilated and thickened. In certain areas the growth tends to undergo cystic degeneration. Lying between the vessels are curious fat-laden cells, similar to the pseudoxanthoma cells seen in hypernephroma. The fat is dissolved out in the usual preparation of the microscopic section, so that the cytoplasm has a honey-comb appearance. The vessels have a tendency to give rise to hemorrhage into the retina, vitreous or subretinal space. In the case of hemorrhage in the vitreous newly formed blood vessels often extend into the coagulum, with the subsequent development of fibrous tissue the later contraction of which is probably a factor in the production of retinal detachment. Subretinal hemorrhage may organize into hard fibrous tissue containing cholesterol crystals, which ophthalmoscopically gives the appearance of white plaques with retinal vessels running over them. In the later stages the glial proliferation is a prominent feature in the picture. This is nicely demonstrated in the recent work of McDonald and Lippincott.[9] In cases of long standing it is not uncommon to find ossification of the choroid of various degrees. Collier [30] emphasized the importance of remembering that the retinal angioma may be microscopic in size.

AGE INCIDENCE

Most of the cases of angiomatosis retinae have occurred in young adults. The average age according to Lindau [31] is 25 years. The

27. von Hippel, E.: Arch. f. Ophth. **118**:384, 1927.

28. Cushing, H., and Bailey, P.: Arch. Ophth. **57**:447, 1928.

29. Atkinson, W. S.: Angiomatosis Retinae with Cerebellar Cyst (Lindau's Disease), Arch. Ophth. **7**:510 (April) 1932.

30. Collier, W.: Brit. M. J. **2**:144, 1931.

31. Lindau, A.: Acta path. et microbiol. Scandinav., 1926, supp. 1, p. 128.

youngest patient in the reported cases is the 2 year old male patient of Emanuel [32] whose eye was enucleated because of a diagnosis of retinoblastoma and which on microscopic section revealed the presence of angiomatosis retinae. Wood [33] reported the occurrence of the disease in a 50 year old woman. In the cases reported the condition involved both eyes in approximately 50 per cent of the patients. One third of the eyes involved had multiple retinal tumors. It is interesting to note that the average age of these patients at the appearance of cerebral symptoms, as based on their hospitalization, is considerably higher, being 34 years in Cushing and Bailey's series [34] and 39 years in Lindau's.[31] As Cushing and Bailey [34] stated: "It is curious that tumors which unmistakably have a congenital anlage like these retinal and cerebellar angiomas should give their first symptoms so comparatively late in life."

GENERAL INVOLVEMENT (LINDAU'S DISEASE)

As previously stated, it was Lindau [2] who first associated cerebellar cysts, pancreatic cysts and cystic kidney with Hippel's disease. Lindau discovered several cerebellar cysts which seemed to have a hemangiomatous origin and was led through this to search for these cases among the pathologic laboratories of Europe. In one of these cases he found retinal angiomatosis. After this, he studied all available cases of Hippel's disease and found that 20 per cent of the patients had intracranial complications, thus accounting for the tradition among ophthalmologists that Hippel's disease is a serious malady. Later [35] he reported the percentage of cerebral involvement as 25 per cent. These tumors are most frequently found in the cerebellum, where they are median and appear to rise from near the end of the fourth ventricle. Occasionally they arise from the medulla or spinal cord and can be either cystic or solid. They are sharply demarcated from nerve tissue, may be capillary, cellular or cavernous and are rarely pure in type. They are usually found as single tumors but may be multiple in the cerebellum, medulla or spinal cord. In 8 of Lindau's cases there were also pancreatic cysts with capillary angiomas in the walls, and in 10 cases there were also cysts in the kidneys. In 6 of the cases there were hypernephromas. Nevi on the face or near the orbit, as frequently found with angioma of the choroid, have not been reported in cases of angiomatosis retinae. Cushing and Bailey [34] stated that Lindau probably overemphasized the incidence of the angiomatous cerebellar cysts over other cerebellar cysts. It is much

32. Emanuel, C.: Arch. f. Ophth. **90**:344, 1915.

33. Wood, D.: Tr. Ophth. Soc. U. Kingdom **29**:115, 1909.

34. Cushing, H., and Bailey, P.: Blood Tissue Tumors of the Brain, Springfield, Ill., Charles C. Thomas, Publisher, 1928.

35. Lindau, A.: Proc. Roy. Soc. Med. **24**:1, 1931.

less common to have angiomatosis retinae with cerebellar cysts than formerly thought. A thorough study of the fundus should be done in all cases of cerebellar tumor for the possible presence of retinal angiomatosis. Failure to find the retinal tumor does not necessarily rule out angiomatosis, as Lindau [2] and Collier [30] both emphasized that these may be microscopic.

The coincidence of cerebellar symptoms and pathologic involvement of the eye varies a good deal. Sargent [36] reported 8 cases of cerebellar angiomatosis in which there were no retinal angiomas, while in Hall's [37] case of cerebellar cyst there was only a small retinal angioma in one eye. There have been a fair number of cases such as those reported by Koch,[38] Seidel,[39] Lindau [2] and others in which the ocular and cerebellar symptoms developed simultaneously. On the other hand, Davison's [40] patient was free from general symptoms for seventeen years, while one of Brandt's [23] patients was free from cerebellar involvement for twenty-four years. As stated previously, in the average case the cerebral symptoms do not make their appearance for approximately ten years.

FAMILIAL TENDENCY

The familial tendency of angiomatosis retinae was recognized early; the first eyes to be examined microscopically by Treacher Collins [5] were those of a brother and sister. Seidel [39] reported the disease in a brother and sister who were the children of the patient in the first case reported by von Hippel. Tresling's [17] family consisted of two brothers with retinal angiomas and a third brother who had a cerebellar cyst. The mother of these brothers died of a disease of the brain. Lindau's [2] second patient had a sister who died of cerebral tumor and a brother who had an amaurotic eye. In the family described by Rochat [41] the mother died of a cerebellar tumor; her three sons died at 32, 34 and 35 of cerebellar tumors, two of them also having angiomatosis retinae. The daughter was free of the disease but transmitted it to one of her children, so that in this family the disease was present in three generations. In the family described by Möller [42] the father died of a cerebral tumor at 47; of his five children who survived early childhood, two died of Lindau's and Hippel's disease; a third was operated on successfully for a cerebral cyst by Lindau; a fourth died of some renal disease (cyst?), and the fifth was free from any evidence of the malady. The

36. Sargent, P., and Greenfield, J. G.: Brit. J. Surg. **17**:84, 1929.
37. Hall, G. S.: J. Neurol. & Psychopath. **15**:305, 1935.
38. Koch, R.: Virchows Arch. f. path. Anat. **215**:180, 1913.
39. Seidel, G.: Ber. ü. d. Versamml. d. ophth. Gesellsch. **38**:335, 1913.
40. Davison, C.: Bull. Neurol. Inst. New York **5**:72, 1936.
41. Rochat, G.: Klin. Monatsbl. f. Augenh. **78**:601, 1927.
42. Möller, H. U.: Acta ophth. **7**:244, 1929.

one son had three children, two of whom died at 24 and 25 of cerebral tumors. Collier [30] stated that Lindau's disease is familial in about 20 per cent of the cases. Czukrász [43] expressed the belief that the disease is usually transmitted through the female. As seen in the family history of both Möller's and Rochat's patients, some members of the family may have an ocular manifestation while others may have only the cerebellar symptoms and still other members both indications of the disease.

SEX INCIDENCE

Czukrász [43] stated the disease occurs more frequently in the male sex. A survey of the cases reported showed that approximately 60 per cent of the cases reported were in males. Because of the relatively small number of cases, these figures are not particularly conclusive.

PROGNOSIS

In angiomatosis retinae the prognosis is poor not only as far as the first eye is concerned but also as far as the second eye is concerned, as the disease is bilateral in 50 per cent of cases. At first the visual acuity is good, but later the retina degenerates, followed by complete detachment of the retina with secondary glaucoma in most instances. Changes in the blood vessels take place over a wide range. The terminal stage consists in detachment of the retina, followed by secondary glaucoma and a painful eyeball, requiring enucleation. As there is no tendency to metastasis, the enucleation of the eyeball to conserve life is not necessary. As Bedell [8] pointed out, it is important to remember that the blood vessel and retinal changes are progressive. The rate of progression may vary a great deal.

That the prognosis for life was poor in angiomatosis retinae was recognized by Brandt,[23] Aust [15] and others before Lindau showed its relation to general angiomatosis. As is now known, the prognosis for life is extremely grave, as cerebral complications, mostly cerebellar cysts, produce death in about 25 per cent of the cases. The incidence is probably higher, as the cerebral complications may occur many years later. In addition, both von Hippel and Lindau concur that pancreatic cysts occur frequently and finally that multiple tumors have been repeatedly observed in other organs.

ANGIOMATOSIS RETINAE AND PREGNANCY

Armstrong [44] reported a case of angiomatosis retinae in a 22 year old primipara at term. His report presents some practical applications for the ophthalmologist that warrant a review of the case. The ophthalmo-

43. Czukrász, I.: Brit. J. Ophth. **21**:368, 1937.

44. Armstrong, M. V.: Am. J. Obst. & Gynec. **34**:494, 1937.

logic examination was made by Evans,[45] who found that in the right eye, in which the vision was reduced to 10/200, there was fairly well developed angiomatosis retinae with partial detachment of the retina. The vision of the left eye was reduced to bare perception of light, and examination revealed a secondary cataract. Evans expressed the belief that the already dilated and diseased vessels might not withstand the marked vascular strain that inevitably accompanies spontaneous labor, especially in a primipara. For this reason cesarean section under local anesthesia was deemed advisable. The fact that there might be an associated lesion elsewhere in the central nervous system or in one of the parenchymatous organs was also considered in spite of negative results on examination. Section was performed and sterilization was recommended, but consent was refused by the husband. Cesarean section and sterilization certainly seem justified in this condition, as an intraocular hemorrhage would have meant sudden and complete blindness.

DIFFERENTIAL DIAGNOSIS

As long as the red globular mass with its widely dilated vessels is visible, there is no particular difficulty as far as diagnosis is concerned. Later, when the detachment with its white subretinal masses and glial proliferation dominate the vitreous it becomes more difficult. Often the true tumor is small in relation to the amount of recently produced exudation, as illustrated by Gourfein-Welt's [46] patient. In Erggelet's [47] case there was angiomatosis in the left eye, while the right eye had an exudative retinitis, so that on rare occasions the disease may be associated with Coats's disease. There are certain diseases that particularly present themselves in the differential diagnosis of angiomatosis retinae. These have been admirably reviewed by Lloyd.[6] In his article he emphasized the value of the slit lamp and proper transillumination as aids to diagnosis.

Retinitis exudativa externa (Coats's disease), described as an entity by Coats [48] in 1908, is the most difficult to differentiate, especially in the later stages. The conditions may be so similar that Berg [49] concluded that angiomatosis retinae was the early stage of Coats's disease. Clausen [50] expressed the belief that the conditions were sufficiently confusing that the process in some of the cases reported as angiomatosis was exudative retinitis. In Coats's disease, while there is a similarity, the genesis is of an entirely different nature. In the retinitis of Coats it is primarily a

45. Evans, J. N., cited by Armstrong.[44]
46. Gourfein-Welt, E.: Klin. Monatsbl. f. Augenh. **65**:105, 1920.
47. Erggelet, H.: Klin. Monatsbl. f. Augenh. **65**:413, 1920.
48. Coats, G.: Roy. London Ophth. Hosp. Rep. **17**:440, 1908.
49. Berg, F.: Arch. f. Ophth. **98**:211, 1919.
50. Clausen, W.: Klin. Monatsbl. f. Augenh. **69**:844, 1922.

change in the retinal blood vessels which results in hemorrhage which is in turn followed by exudation. The characteristic large wooly mass with vessels running into it is the result of hemorrhages into the subretinal space with subsequent degeneration or organization and the formation of cystic spaces, cholesterol crystals, new vessels and even bone. The condition is almost always unilateral and occurs most frequently in the thirties. It has been reported as early as 6 [51] and as late as the sixties and seventies. Since it occurs at a later age and has a similar etiologic basis, it is not uncommon to find it associated with retinitis circinata. There is no familial tendency in exudative retinitis. As the disease progresses, one finds extensive detachment, pain from iritis or secondary glaucoma that usually requires enucleation. At times angiomatosis retinae may be masked by hemorrhage and exudate in or under the retina, so that it simulates exudative retinitis.

Angioma of the choroid is another rare condition that must be ruled out. It is only occasionally diagnosed in life, one of these instances being reported by Fehr.[52] The ophthalmoscopic appearance is that of a small light gray mass with indefinite outlines and usually situated in the vicinity of the macula. The vessels going into the mass are larger single ones rather than the capillary mesh found in Hippel's disease. The process progresses slowly until retinal detachment or glaucoma and iritis occur. Wagenmann,[53] Steffens [54] and others have reported nevi about the face and orbit in these cases of choroidal angiomas.

Racemose arteriovenous aneurysm of the retina should be considered because of its similarity to the early stages of angiomatosis retinae. The condition consists of a direct communication between an artery and a vein, with marked dilatation and tortuosity of both, the venous side usually being affected more than the arterial. The red globular mass found in angiomatosis retinae is not present. Cases have been reported by Magnus,[55] Gunn,[56] Schleich,[57] Seydel,[58] Ehlers,[59] Rentz [60] and Stokes.[61] According to Duke-Elder,[62] the case reported by Kreutz [63] is

51. Greeves, A.: Tr. Ophth. Soc. U. Kingdom **31**:112, 1911.
52. Fehr, O.: Zentralbl. f. prakt. Augenh. **29**:161, 1905.
53. Wagenmann, A.: Arch. f. Ophth. **51**:532, 1900.
54. Steffens, P.: Klin. Monatsbl. f. Augenh. **40**:113, 1902.
55. Magnus, H.: Virchows Arch. f. path. Anat. **60**:38, 1874.
56. Gunn, M.: Tr. Ophth. Soc. U. Kingdom **4**:156, 1884.
57. Schleich, G.: Mitth. a. d. ophth. Klin. in Tübingen **2**:202, 1884.
58. Seydel, G.: Arch. f. Augenh. **38**:157, 1899.
59. Ehlers, H.: Acta ophth. **2**:374, 1924.
60. Rentz, W.: Arch. f. Augenh. **95**:84, 1925.
61. Stokes, W. H.: Racemose Arteriovenous Aneurysm of the Retina (Aneurysma Racemosum Arteriovenosum Retinae), Arch. Ophth. **11**:956 (June) 1934.
62. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1938, vol. 2, p. 1388.
63. Kreutz, A.: Wien. med. Wchnschr. **53**:1725, 1903.

rather doubtful, so that there have been only 7 authentic cases described in the literature. With the exception of Gunn's case, the vessels of the aneurysm were markedly dilated in all. The condition is usually considered congenital, although Magnus stated that trauma was a factor. Leber [64] and Stokes, however, expressed the belief that the anomaly existed prior to the injury, an opinion that is borne out by study of the case history.

In addition to the aforementioned rather rare conditions, angiomatosis retinae in its various stages must be differentiated from the more common conditions, such as retinoblastoma and other neoplasms, cystitic membrane, changes caused by intracranial tumors, nephritis, tuberculosis, tuberous sclerosis and other constitutional diseases.

THERAPY

A survey of the literature shows surprisingly few data regarding treatment of angiomatosis retinae.

Before the disease was understood, various remedies were tried. Armstrong's [44] patient six years previously had been treated with intravenous injections of arsphenamine, tuberculin and calcium gluconate and roentgen "treatment to head." Alperin [65] expressed the belief that toxemia was a possible factor and suggested foreign protein therapy.

In recent years the attempts at therapy have been limited to irradiation or electrolysis.

Houwer [66] found roentgen therapy unsuccessful, but the vision of the eye was reduced to 1/60 and there were a contracted field, changes in the vitreous and detachment of the retina with exudates before treatment was started. Erggelet [47] found roentgen therapy no help in a case in which the condition was well advanced. McDonald and Lippincott [9] applied radium unsuccessfully in a case in which the condition was advanced; this case had previously been reported by Rhodes.[67] There are other similar reports of this form of therapy in cases in which the condition was well advanced.

Holm [68] employed radium irradiation in 2 cases and witnessed shrinking of the tumors but without recording the end results. R. Foster Moore [69] reported 2 cases of angiomatosis retinae in which treatment with radium was successful. Both patients were women, aged 24 and 36, and in both instances one eye had been lost by the disease and the

64. Leber, T., in von Graefe, A., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, ed. 2, Leipzig, Wilhelm Engelmann, 1915, vol. 7, pt. 1, p. 37.
65. Alperin, D.: Am. J. Ophth. **9**:532, 1926.
66. Houwer, M.: Am. J. Ophth. **2**:820, 1919.
67. Rhodes, D.: Am. J. Ophth. **20**:522, 1937.
68. Holm, E.: Klin. Monatsbl. f. Augenh. **59**:319, 1917.
69. Moore, R. F.: Tr. Ophth. Soc. U. Kingdom **55**:3, 1935.

angioma in the other eye was increasing. In the first patient's eye he placed three 4 millicurie seeds of radon as near the growth as possible. These seeds were left in situ for ten days. A good deal of reaction occurred, which gradually subsided. Six months later there was no neoplasm, the site being occupied by pale stippled pigmented areas. The vessels supplying the growth had become obliterated. In the second case a much smaller dose of seeds was used, namely, two seeds of 2 millicuries each, which were in place only three days. At the end of three months there was only scar tissue present at the site of the angiomatosis. This patient had a large subhyaloid hemorrhage two years later and lost the sight of the eye. Moore gives his technic of application in detail. Traquair [70] treated with radium a 38 year old woman who had angiomatosis retinae. He used 80 mg. of radium applied for twelve and a half hours. The details of application are described. There was a slight reaction, which subsided quickly. Two and a half months later 15 mg. was applied subconjunctivally for seventy-two hours. Sixteen months later the vision of the eye was 6/12. Examination of the fundus showed the vessels to be smaller and the mass more fibrous.

Treacher Collins [71] suggested electrolysis as possible therapy and stated that he would insulate the needle well up to its point and then insert it through sclera and choroid and into the tumor, turning the current on as soon as it entered the tumor to prevent hemorrhage in the vitreous. He would locate the tumor by the method advised by Gonin in localizing retinal holes. Neame [72] reported a case of Hippel's disease in both eyes, but in the early stages. The left eye was treated by electrolysis, a fine sharp round needle being used. Some difficulty was experienced in perforating the sclera. The effect was noticeable in the mottled pigmentation in the neighborhood of the angiomas. A special needle had been prepared similar to that employed in the treatment of spider nevi of the skin. The final results have not as yet been reported.

Bedell,[73] in Berens' "The Eye and Its Disorders," stated the advisable treatment depends on the stage in which the case is seen. "If the condition is recognized early and if the patient has no other angiomatous lesions radium or roentgen ray therapy seems to have a beneficial effect."

COMMENT

With the general prognosis of the disease as poor as it is and in view of the high percentage of cases in which there is a multiplicity of tumors in various parts of the body, therapy at first glance seems rather hope-

70. Traquair, H. M.: Tr. Ophth. Soc. U. Kingdom **53**:311, 1932.

71. Collins, E. T.: Proc. Roy. Soc. Med. **24**:372, 1930.

72. Neame, H.: Am. J. Ophth. **20**:188, 1937.

73. Bedell, A., in Berens, C.: The Eye and Its Disorders, Philadelphia, W. B. Saunders Company, 1936, p. 779.

less. There are, however, a fair number of cases in which general symptoms apparently do not develop. In addition, in some cases in which cerebral involvement occurs later signs of it may not appear for as long as twenty or more years. It is known that without treatment the ocular condition gradually progresses to blindness. Consequently, every possible attempt should be made, in suitable cases, to prevent progression. The pathologic picture of angiomatosis retinae shows clearly that in the later stages with detachment of the retina and glial proliferation therapy can hope to accomplish nothing.

It would appear that irradiation therapy probably offers the best hope if used in suitable cases in the early stage. Turner [74] criticized Bedell [73] and stated that he could not conceive of irradiation being employed in sufficient quantity to affect the lesions without destroying the function of the globe at the same time. Cutler, Jaffe and Grossman [75] have pointed out that many ophthalmologists and radiologists have been reluctant to employ irradiation therapy in and about the eyes because they do not understand what can be accomplished or the nature and duration of the reactions which are to be expected. The reactions to roentgen rays and to radium are essentially of the same order. The tolerance to irradiation increases with the age of the patient. The intensity of the radiation is greatest in the anterior structure of the eye but becomes proportionately less in its posterior structures. . The tolerance of the various structures of the eye has been carefully worked out and is rather well understood. The most dreaded complication of irradiation therapy for ocular lesions is lenticular opacity, a condition that can be corrected by operation and therefore should not be considered too seriously if irradiation means the possibility of saving the function of vision. Clapp [76] could find only 34 cases of postradiation cataracts up to and including 1932.

Irradiation has been used successfully in the treatment of some intraocular tumors. Scheyhing [77] found 8 cases of retinoblastoma in which cure was reported following roentgen therapy. In his case a cataract developed after three years. This was removed, and at the end of four years the patient had 0.6 vision with correction and the tumor showed only regressive changes. In Benedict's [78] case the tumor disappeared after radium therapy, leaving only a flat scar and vision of 6/7. After five years vision was reduced to 6/60 by the presence of lenticular opacities, but there was no evidence of recurrence of the retinoblastoma.

74. Turner, H. H.: Am. J. Ophth. **20**:522, 1937.
75. Cutler, M.; Jaffe, H., and Grossman, A.: Am. J. Ophth. **21**:749, 1938.
76. Clapp, C.: Am. J. Ophth. **15**:1039, 1932.
77. Scheyhing, T.: Klin. Monatsbl. f. Augenh. **98**:756, 1937.
78. Benedict, W.: Proc. Staff Meet., Mayo Clin. **2**:265, 1927.

Moore's [79] patient had a retinoblastoma in his remaining eye that was treated by a radon seed. Four years later the boy still had vision of 6/18. From these reports it appears that the eye does tolerate sufficient irradiation to be effective on tumors without destroying its function.

A critical review of the cases of angiomatosis retinae in which treatment was successful shows 3 reported as cured and 2 as improved but without a report as to the final outcome. In all these cases radium was used. In our case we felt that roentgen irradiation was worth trying because of the newer methods of high voltage roentgen therapy. In view of these few encouraging results, patients with angiomatosis retinae in the early stage should be given the benefit of some form of therapy. This naturally applies only to those cases in which there is no general involvement. At the present time irradiation therapy seems to offer the best prognosis, although it is possible that electrolysis may also become an accepted method of treatment.

REPORT OF A CASE

History.—R. M. P., a 20 year old single girl, reported to the ophthalmic clinic of the University of California for examination on Aug. 11, 1938. As long as she could remember she had had frontal headaches associated with the use of her eyes. She had noticed no apparent difference between her two eyes, although she felt that the left eye was perhaps a little better. Since the age of 12 she had had rather frequent suboccipital headaches, which were not associated with close work. Although these headaches to some extent seemed related to the menstrual period, they came on at irregular intervals and when present were severe enough to cause her to remain in bed. These attacks lasted one to four days, and when they subsided there was a feeling of discomfort in the suboccipital region for some days. There was no vertigo, staggering, nausea or vomiting during these attacks.

The past history was essentially unimportant.

Catamenia began at the age of 12 and was somewhat irregular, coming at intervals of from twenty-two to thirty-four days and lasting five to eight days.

The father, aged 41, was living and well and had no ocular or cerebral symptoms. None of his progenitors had any ocular disease or disease of the central nervous system. The mother, aged 41, was living and well and did not have any ocular or cerebral symptoms. There was no history of hereditary ocular disease or disease of the nervous system. Two sisters, 24 and 15 years of age, and two brothers, aged 23 and 9, had no history of ocular abnormalities aside from refractive errors and gave no history of disease of the central nervous system.

Examination of the fundi of these persons, with the exception of the father, did not reveal any pathologic process.

Ophthalmologic Examination.—The patient had vision of 0.4 + in the right eye; with correction with a —1.0 D.sph. ⊃ —0.5 cyl., axis 105 it was 1.0. Vision in the left eye was 0.8; with correction with a —0.75 cyl., axis 65 it was 0.8 +.

---

79. Moore, R. F.: Am. J. Ophth. **16**:814, 1933.

The test for muscle balance revealed orthophoria for distance and exophoria for near vision.

The pupils were equal, round and regular and reacted to light and in accommodation, also consensually.

External examination of the right eye gave negative results. The media were clear and the fundus normal.

External examination of the left eye gave negative results. The lens showed some fine subcortical opacities posteriorly. The disk was not remarkable except for the vessels. The inferior temporal artery a short distance from the disk was markedly dilated and tortuous as it wended its way to the periphery, where it entered a lobulated reddish yellow mass. In its central portion the artery became sacculated and tortuous, the sacculations being closely coupled. Accompanying the artery was a similar but more dilated tortuous vein which started in the mass. The retinal mass was situated well out in the periphery below and slightly temporal. It was about 3 disk diameters in size and was elevated about 5 diopters. Its surface was lobulated but smooth and of a reddish yellow hue. No other masses were seen in the fundus, and the remaining vessels appeared to be normal. Between the disk and the macula the retina showed patches of pale yellow-white

Details of Roentgen Therapy

Date	Distance, Cm.	Filters	Kilovolts	Milliamperes	Minutes	Roentgens	Skin Erythema Dose
9/19/38	50	0.25 Cu, 0.2 Sn, 2.0 Al	200	15	5.9	184	184
9/21/38	52	0.25 Cu, 0.2 Sn, 2.0 Al	200	15	6.5	200	384
9/23/38	50	0.25 Cu, 0.2 Sn, 2.0 Al	200	15	5.9	184	568
9/26/38	50	0.25 Cu, 0.2 Sn, 2.0 Al	200	15	5.9	184	752
9/27/38	52	0.25 Cu, 0.2 Sn, 2.0 Al	200	15	6.5	200	952
9/30/38	52	0.25 Cu, 0.2 Sn, 2.0 Al	200	15	6.5	200	1,152
10/31/38	52	0.25 Cu, 0.2 Sn, 2.0 Al	200	15	1.6	50	1,202

exudate slightly suggestive of the exudate of retinitis circinata. Above and below the macula were other small scattered patches of this same exudate. Along the dilated vein were other linear streaks of exudate together with some tiny flecks between the artery and the vein.

The visual field of the right eye was normal. In the left eye the peripheral fields showed depression above and below for a 3 degree test object at 330 mm. With small test objects (1 degree at 2,000 mm. and 2 degrees at 2,000 mm.) the fields were normal.

The intraocular tensions of the right eye was 19 and of the left eye 18 (Schiötz).

General Physical Examination.—The results of this examination were negative.

Neurologic Examination.—Nothing of note was found on neurologic examination.

Roentgen Examination.—The chest was normal roentgenographically. The contour and density of the cranial bones were normal. The sella turcica appeared normal. There were no intracranial calcifications. Detail films of the right and left orbits showed optic canals of essentially the same size and configuration. The sinuses and mastoid appeared pneumatic. The roentgen examination showed nothing abnormal.

Diagnosis.—The diagnosis was angiomatosis retinae of the left eye without involvement of the central nervous system.

Treatment.—After consultation with Dr. R. Stone of the roentgenologic department, it was decided to give the patient a course of high voltage roentgen therapy to the eye in an attempt to prevent progression of the disease.

The therapy as given is presented in the accompanying table.

On October 3 the skin above the eye was slightly red with a little conjunctival involvement.

On October 10 considerable photophobia and lacrimation were present. The conjunctiva showed only slight reaction.

On October 21 there was still some burning of the lids. The conjunctiva was slightly red. The vision of the left eye was 0.8. There were no visible changes in the fundus picture.

Neurologic examination at this time again gave negative results. The patient stated that the headaches seemed less.

On November 7 the mass had lost a good deal of its reddish color but was still elevated between 4 to 5 diopters. The vision of the left eye was 0.8. The fundus picture seemed to show some recession of the tumor.

The patient was seen intermittently, and on April 3, 1939, the vision of the left eye was still 0.8. There was no apparent change in the lenticular opacity. The tumor mass was definitely smaller and flatter, being elevated between 3 to 4 diopters, and the mass was of a yellowish color. There was also a definite decrease in the exudate. The blood vessels, however, seemed unaltered. These clinical observations were confirmed by colored fundus photographs taken by Dr. George Campion before treatment and seven months later. The patient will continue under periodic observation.

NOTE.—Since this article was sent in for publication, the patient was seen on Sept. 14, 1939, a year from the time roentgen therapy was started. Examination at this time showed no change in vision. There was a marked decrease in the exudate in the lower and outer portions of the fundus between the disk and the macula. The tumor was smaller and much paler than at the previous examination. There was no apparent change in the blood vessels.

SUMMARY

A girl of 20 with angiomatosis retinae in a fairly early stage was treated by high voltage roentgen therapy.

At the end of seven months there was a definite decrease in the size of the tumor and the amount of exudate. The condition of the vessels was unaltered. This clinical observation was confirmed by colored fundus photographs taken before and after treatment.

The final result cannot be determined for a number of years.

From the evidence in the literature, patients with angiomatosis retinae in the early stage who show no evidence of angiomatous lesions elsewhere should be given the benefit of irradiation therapy. Judging from the results thus far in our case and in those reported, it would appear that localized radium therapy in cases of early involvement produces a greater effect on the tumor mass than does roentgen irradiation.

CYCLODIALYSIS WITH INSERTION OF A METAL IMPLANT IN THE TREATMENT OF GLAUCOMA

A PRELIMINARY REPORT

MANUEL URIBE TRONCOSO, M.D.
NEW YORK

Since Heine devised cyclodialysis (1905) the operation has been tried extensively by many surgeons. It has been called an internal fistulization in the belief that it creates a direct internal channel between the anterior chamber and the suprachoroidal space. Its action is opposed to external fistulization, in which the anterior chamber is made to communicate with the subconjunctival spaces outside of the eye by a trephine or a Lagrange operation.

Cyclodialysis is preferred by some surgeons because it is harmless and free from the dangers of secondary infection. Unfortunately its effects in relieving hypertension are almost always temporary. A permanent result is obtained in only about 20 per cent of the cases. The great number of failures has been ascribed to an earlier and complete cicatrization of the detached scleral insertion of the ciliary body to the scleral spur, which reattaches itself, blocking the aperture between the anterior chamber and the perichoroidal space. The reattachment occurs much more readily when instead of an open angle one has to deal with a peripheral synechia, which has to be detached from the cornea in all its breadth and kept separated if the operation is to be a success.

This distinction in the condition of the angle could not be made before the operation by earlier surgeons, but since the advent of the gonioscope one is able to detect the location of a peripheral synechia and, if possible, to avoid it and thus increase the possibility of success.

The ingenuity of the ophthalmologists has contrived numerous procedures for the purpose of preventing the contact of the membranes and of securing a permanent separation of the ciliary body from the sclera. They can be divided into two groups: (1) inclusion of living tissues and (2) implantation of foreign bodies.

From the Department of Ophthalmology, Columbia University, and the Institute of Ophthalmology of the Presbyterian Hospital.

Read before the Section on Ophthalmology at the Ninetieth Annual Session of the American Medical Association, St. Louis, May 17, 1939.

1. Mauksch [1] (1929) and later Suker [2] (1931) introduced into the cyclodialysis incision a forceps with which they grasped the iris near the pupillary border and pulled it forcibly between the ciliary body and the sclera to about half of the length of the tunnel. This method had some disadvantages. As the scleral incision had to be very large to allow the introduction of the forceps down to the anterior chamber, several complications followed: injury and detachment of the ciliary body with extensive hemorrhage, loss of vitreous, injury of the lens and later prolapse of the choroid into the scar.

To avoid these complications, del Barrio [3] (1935) made the scleral incision smaller and used a blunt hook to engage and pull the iris back until it appeared at the scleral wound. Then the pupillary margin was resected to avoid displacement of the iris back into the anterior chamber. Del Barrio reported 39 cases with good results.

Halben [4] (1909) proposed the transplantation of living vessels into the cyclodialysis wound. He contemplated the use of calves' arteries to produce drainage from the anterior chamber to the subconjunctival space through the tunnel made by cyclodialysis, but he never tried it experimentally or clinically. Sondermann [5] (1934), wishing to make a connection between the vessels of the angle and the episcleral veins, made a scleral opening 3 mm. from the limbus, and after detaching the ciliary body with a spatula he inserted a strip of conjunctiva into the wound. The cicatrization, however, produced a thick scar, and no effect was obtained in reducing the tension.

2. Foreign bodies of different kinds have been tried for the purpose of avoiding reattachment of the ciliary body. Row [6] (1934) used experimentally iridium-platinum wire and horsehair in two rabbits. Later he implanted horsehair in three human eyes affected with glaucoma. The first operation was attended with considerable hemorrhage from the iris. Healing was uneventful, and tension was lowered; however, the eye remained irritable, and epiphora was present. The ends of the horse-

---

1. Mauksch, H.: Ein Vorschlag für eine neue Glaukomoperation, Ztschr. f. Augenh. **67**:313-322, 1939.

2. Suker, G. F.: The Filtration Operation of Mauksch for Chronic Glaucoma with Preliminary Report on Twenty-Four Operations, Am. J. Ophth. **14**:732-735, 1931.

3. del Barrio, A.: La fistulisation interne par l'iridenclésis scléro-ciliaire dans le glaucome, Ann. d'ocul. **171**:977-998, 1934; La fistulización interna por iridoenclesis esclerociliar en el glaucoma, Arch. de oftal. hispano-am. **35**:355-374, 1935.

4. Halben, R.: Dauerdrainage des Augapfels durch Blutgefässtransplantation in den Bulbus: Vorläufige Mitteilung, Arch. f. Augenh. **62**:392-394, 1909.

5. Sondermann, R.: Eine neue Glaukomoperation, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **50**:78-81 and 85-86, 1934; Klin. Monatsbl. f. Augenh. **93**: 227-230, 1934.

6. Row, H.: Operation to Control Glaucoma: Preliminary Report, Arch. Ophth. **12**:325-329 (Sept.) 1934.

hairs tended to break through the conjunctiva, so in his second case Row buried them under Tenon's capsule. He admitted that the operation might induce sympathetic ophthalmia, as the foreign body remains in the eye forever and late infection may occur. Brecher [7] (1936) in a case of acute glaucoma inserted the membrana testacea of eggshell, properly sterilized. Weekers [8] (1922), to obtain permanent drainage of the vitreous, used a gold ring adjusted to a trephine hole made in the sclera at a distance of 7 mm. from the limbus. Zorab [9] (1912) and Wolfe and Blaess [10] (1936) used silk threads to secure drainage of the anterior chamber into the subconjunctival space.

Many of these methods, however, have failed to gain a permanent place in ophthalmic operations on account of the dangers incurred in some of them and the lack of permanent results in the treatment of hypertension in others.

MAGNESIUM IMPLANTATION

The operation that I shall present for consideration is based on the use of the metal magnesium, implanted between the sclera and the ciliary body after cyclodialysis. Metals and other foreign bodies which penetrate inside of the eye have proved so disastrous on account of the great inflammatory reaction they produce and the danger of sympathetic ophthalmia that it seems strange to speak of a method in which a piece of metal is deliberately left inside the eyeball. Chemically indifferent bodies like glass, if they are aspetic, can be tolerated without ill effects for a long time. On the contrary, aseptic chips of metal which stay for some time inside of the eye usually set up a severe inflammation. Iron and steel become ionized and oxidize. Finally they are converted into bicarbonate of iron suboxide, which forms granular deposits of a rusty yellow color. These diffuse throughout the eye (siderosis) and are redeposited around the vessels and solitary lymphatics (Koeppe). The toxic effect of iron causes a more or less marked inflammatory and degenerative reaction, which may entail destruction of vision or even of the eye itself. Copper splinters are extremely toxic, and even when aseptic they excite a severe chemical irritation (chalcosis). In some cases they are even eliminated from the eye by an inflammatory toxic process.

---

7. Brecher, I.: Ueber eine neue Modifikation der Zyklodialyse (Vorläufige Mitteilung über einen Fall), Klin. Monatsbl. f. Augenh. **96**:235-237, 1936.

8. Weekers, L.: Le drainage permanent du vitré dans le glaucome, Arch. d'opht. **39**:279-284, 1922.

9. Zorab, A.: Relief of Tension in Chronic Glaucoma: Preliminary Report on a New Operation, Tr. Ophth. Soc. U. Kingdom **32**:217-234, 1912.

10. Wolfe, O. R., and Blaess, M. J.: Seton Operation in Glaucoma, Am. J. Ophth. **19**:400-406, 1936.

My attention was first called to the use of magnesium as an implant by the researches of Payr,[11] who ingeniously tried to suture blood vessels and nerves, using cylinders made of magnesium. Contrary to what happens with other metals, magnesium easily disintegrates and is absorbed by the tissues of the body in about two or three weeks. It is entirely harmless and produces little reaction. Payr and Martina used it with success not only to reestablish the continuity of vessels and nerves but for the suture of the liver.[12] It has been tried in cholecystectomy and in operations on bone.

The first investigators to make use of magnesium in the eye in an experimental way were Morax and Chiazzaro.[13] They introduced into the anterior chamber of a rabbit a small piece of the metal about 3 to 5 mm. long and weighing 1 mg. This had been previously sterilized by dry heat at a temperature of 170 F. A few minutes after the inclusion, bubbles of gas started to develop around the metal. In the following days they could observe the disintegration and complete absorption of the magnesium in the anterior chamber. The eye showed almost no reaction. They also implanted a small piece in the vitreous, and with the ophthalmoscope they could see it completely absorb as fast as in the aqueous, in about two weeks. It took the metal longer to absorb under the conjunctiva, the ratio of solubility in the subconjunctival tissue to that in the aqueous being about 1:2. Placed under the skin of the ear, magnesium was absorbed in about the same time as under the conjunctiva.

In 1936 Chiazzaro [14] implanted a small piece of magnesium weighing 1 mg. into a hole made by trephining in 2 patients with chronic glaucoma. His purpose was to prevent secondary adhesion of the conjunctiva, which so often closes the aperture of trephining and invalidates the result of the operation. He reported good results, the intraocular tension remaining lower.

When I had the idea of using magnesium after cyclodialysis to avoid reattachment of the ciliary body to the sclera, my first step was to repeat Morax and Chiazzaro's experiments with animals. I found them

11. Payr, E.: Beiträge zur Technik der Blutgefäss- und Nervennaht nebst Mitteilungen über die Verwendung eines resorbierbaren Metalles in der Chirurgie, Arch. f. klin. Chir. **62**:67, 1900.

12. Payr, E., and Martina, A.: Experimentelle und klinische Beiträge zur Lebernaht und Leberresection (Magnesiumplattennaht), Arch. f. klin. Chir. **77**: 962-998, 1905.

13. Morax, V., and Chiazzaro, D.: Sur la résorption du magnésium métal dans l'organisme et plus spécialement dans le globe oculaire, Ann. d'ocul. **167**:809-815, 1930.

14. Chiazzaro, D.: Sur la résorption du magnésium métal dans l'œil humain: Note préliminaire sur son application dans le glaucome chronique, Ann. d'ocul. **173**: 689-702, 1936.

accurate, the eyes of rabbits and dogs showing little reaction to a small piece of magnesium weighing 1 mg. introduced in the anterior chamber and vitreous. I later tried large amounts of the metal implanted in the anterior chamber after cyclodialysis to determine: (1) the reaction and limit of tolerance of the eye, (2) the histologic lesions produced around the foreign body in the inner membranes and (3) the variations, if any, of intraocular pressure.

EXPERIMENTAL WORK

CHEMICAL PROPERTIES

Magnesium is produced as a pure metal by an electrolytic process. Its color is silver white in dry air, but in a moist atmosphere it changes to a dull hue, being coated with a thin layer of whitish oxide. Magnesium burns with a white luminous flame and is used extensively for instantaneous photography. It is found in the market as a ribbon or as wire. It can easily be cut out with scissors, hammered and rolled into cylinders such as Payr used for sutures of the vessels and nerves. It dissolves slowly, even in water, giving forth numerous small bubbles of hydrogen. If the water has a high temperature, the rate of dissolution is increased. The magnesium strips start disintegration by changing color and then becoming rough and black after three or four days. Grooves, gaps and holes form on the surface, and then small pieces fall apart and are dissolved. Payr expressed the belief that the chemical process is one of oxidation by the oxygen contained in the blood. This is not the case, as magnesium dissolves in vitro in different mediums, the only difference being the amount of time the dissolution requires.

In the body tissues the action of carbonic and lactic acids produces a carbonate of magnesium. The metal is so electropositive that it can replace hydrogen from water. The gas becomes free, giving forth bubbles of free molecular hydrogen. Magnesium is further catalyzed by hydrogen ions, especially carbonic hydroxyl ions, from any acid in the tissues that is in alkaline solutions.

Aluminum was also used experimentally by Payr. It is reabsorbable by the tissues, but much more slowly than magnesium. It is easily soluble in alkaline solutions and diluted mineral acids generating oxygen bubbles. Magnalium, or the alloy of aluminum and magnesium, is a pliable, more absorbable metal which has also been used for sutures.

TECHNIC OF IMPLANTATION IN THE EYE

Morax and Chiazzaro, using about 1 mg. of magnesium in the anterior chamber and the vitreous, observed little reaction in the eye. In my own researches, when a larger amount (from 3 to 5 mg.) was deposited in the anterior chamber a mild reaction appeared, with redness

of the conjunctiva and pericorneal injection. This did not last more than a few days, and at the end of two weeks the magnesium and bubbles of gas had entirely disappeared, the eye becoming normal again.

When I was convinced of the harmlessness of magnesium, I started to use an implant in the eyes of rabbits after performing cyclodialysis. The technic of the operation is considerably more difficult in lower animals than in man. Figure 1 shows a section of the angle of the anterior chamber in a normal rabbit eye as seen by the microanatomic method with the slit lamp.[15] The ciliary body is divided in two parts; one, *AC*, is attached to the sclera by a large firm insertion at a considerable distance from the corneal junction and similar to the insertion of the scleral spur in man. The other part, *DC*, is detached from the sclera and forms the internal wall of a triangular cavity running all around the limbus: the cilioscleral sinus, *CS*. The detached, or iridic,

Fig. 1.—Microanatomic section of a rabbit's eye. *C*, indicates the cornea; *S*, the sclera; *I*, the iris; *PL*, the pectinate ligament fibers; *CS*, the cilioscleral sinus; *Cy*, the incision for cyclodialysis, and *D*, Descemet's membrane.

part of the ciliary body, *DC*, is bound to the sclera at the level of the lower part of the corneal junction by a series of stout conical teeth, which run through the cilioscleral sinus; they are the pectinate ligament fibers, *PL*. The scleral incision for cyclodialysis has to be made far away from the limbus (about 8 to 10 mm.) to reach the perichoroidal space, the anterior end of which is posterior to the insertion of the ciliary body, *AC*. If the scleral incision is made too near the limbus, the knife falls into the cilioscleral sinus only. After the scleral incision is made, when the spatula is introduced considerable resistance is

15. Troncoso, M. U., and Castroviejo, R.: Microanatomy of the Eye with the Slitlamp Microscope: I. Comparative Anatomy of the Angle of the Anterior Chamber in Living and Sectioned Eyes of Mammalia, Am. J. Ophth. **19**:371, 481 and 583, 1936.

felt to its progress. Even after the insertion of the ciliary body is detached, the spatula has to break through the pectinate fibers. These are so tough that I prefer in my operations to use a narrow Graefe knife instead of the spatula, dividing the pectinate ligament progressively from back to front. Even then the traction on the fibers is such that frequently the end of Descemet's membrane is detached from the cornea. There is usually also a small hemorrhage from the ciliary body. As the knife edge is only on one side, it is better to start its radial movement from one end of the incision to cut all the pectinate ligament fibers in a sweeping movement. The implant used at first was a single strip of magnesium 2 mm. wide and 8 mm. long; it was carefully introduced, being kept close to the inner surface of the sclera to avoid injuring the ciliary body and the choroid. The inclusion proved difficult on account of the width of the strip. In the first experiments the sharp edges of the metal cut the choroid, producing loss of vitreous. To avoid this occurrence, the implant was divided into two strips, each 1 mm. wide

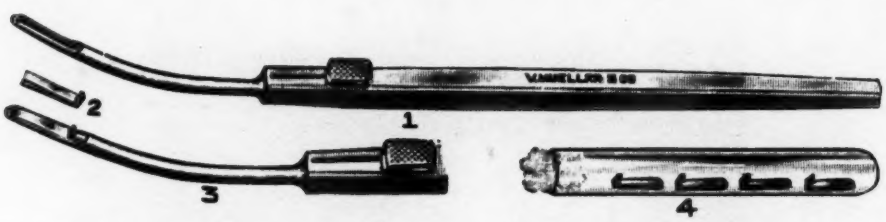


Fig. 2.—*1*, conductor or carrier for insertion of the magnesium implant in the cyclodialysis wound, showing the square groove where the metal strip, *2*, is to be placed. The stem of the spatula is hollow and inside slides a rod, which, controlled by the finger placed on the square button, keeps the implant in place when the carrier, *3*, is withdrawn. *4*, glass tube containing the implants for sterilization by dry heat.

and placed one above the other. As the introduction was difficult even with this arrangement, I devised a director, or carrier (fig. 2, *1*), consisting of a spatula grooved on its upper surface to form a square container, inside of which the implant (*2*) could be wholly accommodated. Later, as an improvement, the shaft of the carrier (*3*) was hollowed and a pusher enclosed, which by pressure of the finger will slide down, keeping the implant in place while the carrier is withdrawn from the wound. In this way one hand alone can insert the instrument, direct it into the anterior chamber with the implant, and then withdraw it from the wound, preventing the strip from escaping out of the sclera.[16] Instead of the ordinary conjunctival incision for cyclodialysis, I found that a quadrangular flap provides a larger field for the operation, covers

16. The carrier is made by V. Mueller & Co., Chicago.

the implant better and keeps it in position. To make this flap, the conjunctiva is sectioned about 2 mm. from and parallel to the corneal limbus in a length of 8 mm. Two other incisions at square angles with the ends of the former give a conjunctival flap which is dissected and raised backward until the sclera is laid completely bare. Once the implant is in place, the flap is lowered and sutured to the edges and the middle of the incision (fig. 5). To prevent the implant from sliding into the anterior chamber or, on the contrary, from coming out of the incision, it is better to bend the external tip squarely for about 0.5 mm. This vertical projection raises the conjunctival flap, which in turn presses over it. It also allows the excess of hydrogen bubbles to escape from the eyeball.

The ciliioscleral sinus of the dog is different from that of the rabbit. The pectinate ligament is made of more delicate fibers; they run in a fanlike manner from the end of Descemet's membrane and nearby cornea to the whole length of the detached ciliary body, filling the sinus entirely.[15] Section of the pectinate ligament is equally difficult in the dog and in the rabbit. It is much easier in the monkey, whose eye is similar to that of man. In the monkey the insertion of the ciliary body to the sclera, at the scleral spur, has advanced forward, near the posterior border of the new organ characteristic of primates: the Schlemm canal.

POSTOPERATIVE COURSE

Cyclodialysis with the insertion of an implant was performed on the eyes of 18 rabbits, 2 dogs and 1 monkey. It is not necessary to describe in detail the postoperative course in all animals, and I shall limit myself to an outline of its progress in some of them. Immediately after the implant was in place, bubbles of gas appeared at the visible tip in the anterior chamber. The metal changed color from brilliant white to dull white. The bubbles were at first small and surrounded the metal entirely. In the course of a few hours the bubbles coalesced and formed large ones, which sometimes filled one fourth or one third of the anterior chamber. Sometimes blood appeared in the anterior chamber after the scleral incision was made. This was usually due to the suction into the chamber, when bleeding had not been entirely controlled in the sclera and the conjunctiva. The day after the operation the eye usually showed some reaction, with pericorneal injection and slight chemosis of the third lid. The pupil was often contracted. The anterior chamber kept its normal depth. The conjunctival flap was congested and raised by the bubbles of gas. In some animals the reaction was more apparent in the flap than around the limbus, even small hemorrhages appearing under the conjunctiva. The number of bubbles in the anterior chamber was variable and depends probably on the patency of the fistula between the anterior chamber, the perichoroidal space and the subconjunctival

Results of Cyclodialysis with Metal Implant in Eight Cases

Case No., Age	Diagnosis	Previous Operations	Tension and Vision Before Implant	Date of Magnesium Implant	Tension One Month After Operation	Tension Two Months After Operation	Results
1 62 yr.	R. E.: Chronic simple glaucoma	R. E.: Trephine, Jan. 25, 1938	R. E.: Tension 38 and vision 20/30 with correction on Dec. 21, 1938	R. E.: Jan. 20, 1939	R. E.: Tension 19, Feb. 15, 1939	R. E.: Tension 19, March 15, 1939	Good
	L. E.: Absolute glaucoma	L. E.: Trephine 1 year before; trephine, Feb. 8, 1938	L. E.: Tension 47; perception of light	L. E.: April 26, 1938	L. E.: Tension 19, May 25, 1938	L. E.: Tension 15, June 22, 1938	Good
2 68 yr.	R. E.: Absolute glaucoma	R. E.: Cataract, 3 years before; trephine 1 year after cataract operation	R. E.: Tension 75; perception of light L. E.: Tension 20; vision 20/20	R. E.: April 26, 1938	R. E.: Tension 35, May 20, 1938 L. E.: Tension 22	Patient did not return to clinic	Apparently good
3 3 yr.	O. U.: Congenital glaucoma	R. E.: Trephine with iridectomy, May 2, 1936; trephine 1 year later; cyclodialysis June 20, 1938 L. E.: Trephine with iridectomy, May 11, 1936	R. E.: Tension considerably elevated to touch	R. E.: Nov. 22, 1938	R. E.: Tension good to touch, Dec. 16, 1938; cornea clear; eye quiet	Same as in case 2	Apparently good
4 11 mo.	O. U.: Congenital glaucoma	No operations	R. E.: Tension 34 L. E.: Tension 34	O. U.: April 5, 1939	Low to touch	Same as in case 2	Apparently good
5 Negro 52 yr.	O. U.: Chronic noncongestive glaucoma	R. E.: Trephine with complete iridectomy, June 1938; trephine, July 12, 1938 L. E.: Trephine with peripheral iridectomy, Jan. 21, 1938; cyclodialysis with iridectomy, Oct. 10, 1938	R. E.: Tension 44, Dec. 9, 1938; vision 20/70, Nov. 18, 1938 L. E.: Tension 25, Jan. 6, 1939; vision 2/100	R. E.: Dec. 13, 1938 L. E.: Jan. 10, 1939	R. E.: Tension 40, after massage was 30 on Dec. 23, 1938 L. E.: Tension 48, Feb. 3, 1939	R. E.: Tension 40, Jan. 23, 1939 L. E.: Tension 35, March 3, 1939	Improvement, then relapse Same as in the right eye
6 56 yr.	R. E.: Iridocyclitis and secondary glaucoma; acute attack	R. E.: Combined intracapsular cataract extraction, June 18, 1938; trephine with iridectomy, Sept. 27, 1938	R. E.: High tension; acute attack; October 23: perception of light	R. E.: Oct. 25, 1938 Dec. 13, 1938	R. E.: Tension after second operation oscillated between 30 and 35; vision 20/30 with correction; eye quiet	R. E.: Tension 30; vision 20/30 with correction	Great improvement
7 41 yr.	O. U.: Chronic noncongestive glaucoma; congenital syphilis	No operations	R. E.: Tension 47; vision 20/70 with correction L. E.: Vision 20/200 with correction	R. E.: Feb. 21, 1939 Trephine, March 7, 1939	R. E.: Tension 20 when discharged from hospital	Unknown	Unimproved
8 54 yr.	R. E.: Chronic noncongestive glaucoma; acute attack	No operations	R. E.: Tension 60 on admission; perception of light	R. E.: Nov. 22, 1938	R. E.: Tension 27, Dec. 21, 1938	R. E.: Tension 22, Jan. 15, 1939; tension 35, April 1939	Good result, then relapse

space. In some animals the anterior chamber had an enormous bubble, while in others the gas moved under the conjunctiva. The symptoms of reaction to the foreign body increased from the day of operation until the third or fourth day afterward. They slowly subsided and were little apparent at the end of the first week. A cytologic test made in the aqueous of the monkey one week after cyclodialysis gave the following results: numerous polymorphonuclear leukocytes, numerous lymphocytes, few large monocytes and a fibrin clot. The inflammatory symptoms disappeared entirely, the eye becoming normal again, from two weeks to twenty days after the operation.

The intraocular tension in all animals was lower in the eye that was operated on than in the fellow control eye, as shown in figure 3. It was at first as low as 5 or 6 mm. of mercury when the aqueous was drainage under the conjunctiva. Later it rose to 10 or 15 mm., while in the control eye the tension was normal: 15 to 20 mm.

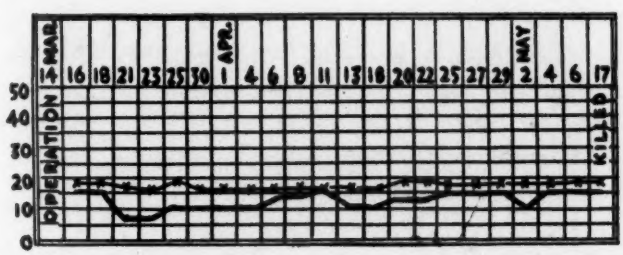


Fig. 3.—Tonometric curve of rabbit 68. The right eye was subjected to cyclodialysis with insertion of a magnesium implant. The period of observation lasted two months and three days. The tension of the right eye was always lower than that of the control eye until the animal was killed. The hatched curve represents the tension in the control left eye; the solid curve, the tension in the right eye.

In some animals, especially when the choroid was perforated, I was able to observe some bubbles in the vitreous just behind the lens. With the + 20 lens of the ophthalmoscope they appeared as round black bodies with a lighter, usually shining center. These bubbles usually disappeared in two or three weeks. The reaction of the eye depends to a great extent on the amount of metal introduced. With small amounts (1 mg.) there is almost no change, but when the amount of magnesium is increased the reaction also increases. However, it is remarkable how little inflammation is produced by such large foreign bodies as were implanted, although they remained in contact with such sensitive membrane as the ciliary body for two weeks before being absorbed. When the healing is complete, the scleral scar appears through the conjunctiva as a bluish spot about 2 or 3 mm. in size and depressed. The enucleated rabbit's eye is best seen from the outside with the slit lamp

microscope. The scleral scar appears thin and depressed. Usually its anterior border is sharper, and the conjunctiva is adherent to the whole surface.

Complications.—In some rabbits, when the magnesium was too long and touched the posterior surface of the cornea this became slightly clouded at the end of three or four days. The opacity usually disappeared when the implant was wholly absorbed. In 3 or 4 animals I observed a greater reaction than in others; the pupil was covered with a slight exudate, and a hemorrhage appeared in the anterior chamber. This inflammation subsided in one or two weeks; the hyphema was reabsorbed, and the eye returned to normal. As the pectinate ligament is practically destroyed inside the cilioscleral sinus in rabbits and dogs, the cicatrization abolishes the sinus, and the detached ciliary body and root of the iris are brought more or less in contact with the outer scleral wall. The root of the iris in some cases advances farther on the cornea and produces a peripheral synechia. This can be detected in vivo by a drawing up of the pupil, which takes an oval shape. An important complication is the loss of vitreous. This can be avoided if the carrier bearing the implant is introduced carefully and is kept close to the inner scleral wall. None of the animals had any permanent ill effects. All recovered with clear corneas, although in some of them anterior peripheral synechiae remained.

Limits of Tolerance.—An experiment was performed to determine the reaction to large amounts of magnesium.

Seven and forty-two hundredths milligram was implanted in the eye of rabbit 74. Immediately after operation the eye became very red. One hour later gas had been produced in such large amounts that even the lids were slightly swollen. The anterior chamber was about half filled with gas. The implant being large, it touched the posterior part of the cornea. The next day an opacity appeared at this point. In addition, there was a membranous exudation in the anterior chamber binding the pupil to the implant. A large bubble of gas filled the upper part of the chamber. Eight days later the reaction had considerably diminished, and after twenty days the eye looked almost normal, although a radial opaque band remained on the cornea at the site of the implant, and behind it an anterior peripheral synechia could be observed. When the animal was killed forty-six days after operation the eye was entirely normal except for the corneal scar.

Comment: It is surprising how quickly the great inflammatory reaction produced by such a large foreign body abated, leaving a practically normal eye except for an anterior synechia.

MICROSCOPIC PICTURE

After periods of time ranging from ten to sixty days, the eyes of animals that were operated on were removed, and serial sections were made both in the meridional and in the transverse direction at the site of the implant. The first thing that strikes the observer is the frequency

of the detachment and rupture of Descemet's membrane. This is easily explained if one remembers that on account of the great number and toughness of pectinate fibers in lower mammals a knife has to be used and that Descemet's membrane is adherent in the rabbit and dog to the tips of the pectinate strands. In simple cyclodialysis without the use of an implant the scar between the ciliary body and the sclera has been found to be thin and of a dense nature. When magnesium is used, conditions are wholly different. The metal stays between the ciliary body and the sclera for fifteen to twenty days and hinders the course of cicatrization.

Before describing the pathologic process in the eye, I shall consider first what occurs in other tissues of the body around the implant. Payr found histologically that the cicatricial process produces at first sharply demarcated masses of new connective tissue containing "gas cysts" the walls of which consist of a connective tissue poor in nuclei and vessels. When the gas becomes absorbed, the walls of the cysts move nearer to each other and a coarse fibrous scar is formed. Payr mentioned also that a granulation tissue may be formed in the vicinity of the foreign body. There is in some cases development of foreign body cells which contain small black metal pieces. Leukocytes mass around the foreign body and also contain black metal granules.

In my experiments with implantation of magnesium after cyclodialysis serial sections were made of the enucleated eyes of all animals. It is not necessary, however, to describe them in detail, as the histologic process was similar. I shall confine myself to report in full the more characteristic ones.

RABBIT 64.—This rabbit was killed twenty days after operation. The end of Descemet's membrane was detached and lay in a mass of fibrous tissue, which was continuous with an extensive anterior synechia. The ciliary body was edematous and appeared partially disorganized. There was considerable connective tissue between the ora serrata and the sclera. There was no evidence of a channel or continuity between the anterior chamber and the suprachoroidal space. On the surface of the sclera, over the ora serrata, there was a scar and above it a space in the episclera. At the scleral scar the fibers were defective, and there was a mass of connective tissue surrounding an irregular foreign body of a gray color. In the next two sections the much infiltrated scar tissue was continuous with the connective tissue in the suprachoroidal space, which extended forward to the angle at the region of the detached end of Descemet's membrane.

RABBIT 62 (fig. 4).—This animal was killed twenty-six days after operation. The sections were examined by Dr. A. B. Reese, who reported as follows: "Extending through the sclera at the site of the operation several millimeters posterior to the scleral spur was an absolutely clear empty space which probably was filled with gas. It was surrounded by a thin but dense connective tissue capsule. From this site posteriorly in the choroid were several of these round clear areas surrounded by the same type of fibrous capsule. The overlying pigment epithelium had proliferated, and the retinal tissue was adherent. The proliferated pigment

epithelium had formed a rather thick layer. From the site of the operation anteriorly in the ciliary body were fewer and smaller clear round areas, and the overlying pigment epithelium had proliferated together with the nonpigmented epithelium of the ciliary body, the latter forming quite an appreciable layer. The ciliary body as a whole was rarefied and much thicker than usual, owing to proliferation of fibrous tissue. Here, also, the overlying pigment epithelium and nonpigmented epithelium had proliferated. Descemet's membrane was detached and quite curled. Throughout all of the aforementioned areas there was a mild lymphocytic infiltration."

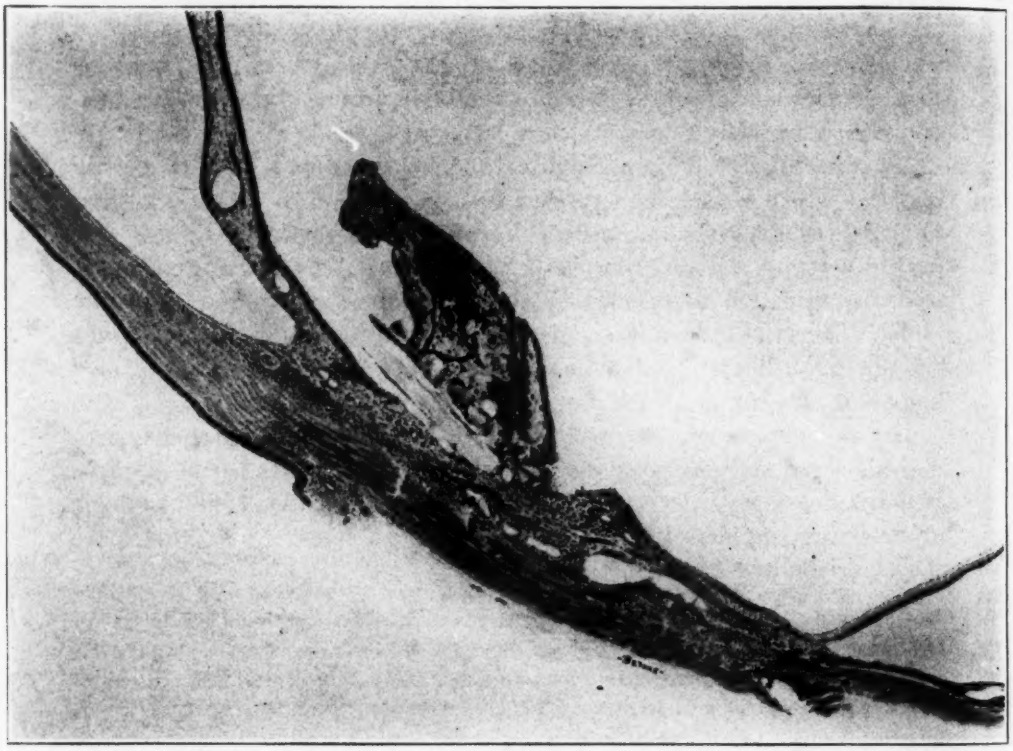


Fig. 4.—Histologic section of the right eye of rabbit 62, killed twenty-six days after operation.

RABBIT 67.—This animal was killed two months after operation. At the extremity of Descemet's membrane the iris was edematous and adherent to the cornea. Posterior to this there was some rarefaction of the ciliary body and processes and some spaces between the ciliary body and the sclera. There was new connective tissue in small amounts between the ciliary body and the sclera, with spaces extending posteriorly into the retina and site of the scleral adhesion. At the region of the ora serrata there was a rather loosely arranged connective tissue scar which extended into the retina and forward into the ciliary body. The ciliary body was separated from the sclera here by a number of spaces, some of them lined by epithelium and others by pigmented tissue. This vascularized tissue extended forward, where it disappeared at the site of an adhesion between the root of the iris and the posterior cornea.

COMPLEMENTARY OPERATIONS

Iridectomy.—After a keratome incision, a large peripheral iridectomy was performed on the eye of a rabbit, and a strip of magnesium 3 mm. long was introduced into the anterior chamber. The external tip of the metal was bent squarely over the incision to prevent it from falling into the anterior chamber. The tip was then covered with conjunctiva. The purpose of this was to allow a direct contact of the metal with the lens and see if an opacity resulted. There was the ordinary reaction with numerous bubbles of gas. The cornea became slightly turbid where the implant touched it, and a slight hyphema collected. The conjunctival flap was raised by gas, and its center took on a whitish necrotic color. After one week the reaction subsided. Examination after instillation of atropine showed no opacity in the lens. After two weeks the metal was still visible. With the slit lamp, small brilliant particles were seen scattered on the iris.

Microscopic Examination: A scar extended through the limbus and the periphery of Descemet's membrane on one side. Sections showed that an iridectomy (peripheral) had been performed in the region of the scar, which contained much pigment. There was no evidence of injury to the lens in the sections examined.

Catgut Implantation.—In order to compare the reactions produced by magnesium and catgut implanted in the eyes of rabbits after cyclodialysis, two pieces of heavy catgut (no. 2, plain) were inserted in the left eye of rabbit 65. They were placed side by side between the ciliary body and the sclera, the inner ends appearing into the anterior chamber while the outer ones were cut through at the surface of the sclera. The conjunctival flap was then lowered and sutured. The reaction to this foreign body was not considerable. The cornea became slightly opaque near the site of the implant. One week later the reaction subsided around the limbus, but at the scleral wound there was a large protrusion, which kept increasing. At the end of the second week the conjunctival flap was not yet cicatrized. When one of the margins was raised, the catgut threads were seen coiled under the ectasia. The fundus of the eye examined with the ophthalmoscope at that time showed that choroiditis had developed. White patches and pigment spots were massed near the nerve head. The animal was killed one month after the operation, when the eye appeared normal.

Microscopic Examination: The reason the reaction subsided so quickly at the limbus was that the ciliary body promptly reattached itself to the sclera. The catgut slid backward and was coiled under the incision, raising the sclera and appearing as a marked ectasia, lined all over with ciliary body. At the site of the operation there was a thin layer of fibrous connective tissue without evidence of spaces, or lacunae, between the ciliary body and the sclera. This fibrous tissue extended forward to the end of Descemet's membrane, which was detached for a short distance on the posterior surface of the cornea. There was a leukocytic reaction in the subconjunctival tissue, but the main reaction was in the sclera at the region of the scleral incision. The iris and ciliary body showed considerable rarefaction, with large adhesion to the posterior cornea and extensive deposits of granulation tissue at the root of the iris, adjacent to a mass of fibrin. Numerous spaces appeared between the defect in the sclera over a considerable area, the defect being filled with granulation tissue lined internally by ciliary body and processes. In some regions the posterior chamber and anterior chamber communicated with the area of granulation tissue.

COMMENT ON MICROSCOPIC CHANGES

Although no conclusion can be drawn from the reactions of normal animal eyes as to the behavior of human pathologic eyes in the same con-

ditions, still some facts may be ascertained in relation to the reaction of tissues to the magnesium implant and the character of the cicatricial tissue formed when the healing takes place.

First, it has been proved that the degree of the inflammatory reaction is in close relation to the size of the foreign body. With a foreign body under 5 mg., the iris and ciliary body develop a mild inflammation, which quickly subsides when the magnesium is absorbed. With one from 5 to 8 mg., the reaction is considerable, with corneal opacity, exudates in the anterior chamber and a longer, protracted period of healing. The presence of the foreign body and the development of gas around its surfaces and in the anterior chamber produce a rarefaction in the stroma of the ciliary body, where numerous spaces are formed. The pigment epithelium proliferates in the ciliary body and becomes scattered throughout the processes. The mildness of the inflammatory reaction produced is surprising in view of the size of the foreign body. Later, the retrograde process develops a new connective tissue at the place where the metal is becoming absorbed. This scar tissue is permeated with numerous empty spaces, which Payr called "gas cysts"; these spaces usually are surrounded by a thin, but dense connective tissue capsule. The scar extends from the anterior chamber through the suprachoroidal space to the site of the scleral incision, which is thin and depressed. There is never a continuous channel all through the scar. In rabbits and dogs the cilioscleral sinus is obliterated by this lacunar fibrous tissue, which ends in some cases under the conjunctiva at the scleral incision, joining the separated lips of the section. These lesions end abruptly on either side of the site of the implant.

TECHNIC OF OPERATION IN MAN

I used in my operations the ordinary method of cyclodialysis, but with some modifications to insure the proper inclusion and permanence of the implant inside the eyeball. Akinesia of the lids is convenient, and more important still is a retrobulbar injection of procaine hydrochloride, which not only gives better anesthesia but produces a lowering of the intraocular pressure. This is useful for the performance of the operation and to a certain extent to prevent perforation of the choroid. The scleral incision should be placed where the angle is open, or at least where only a trabecular synechia exists, preferably in the space between the insertion of the rectus muscles. The patient is directed to look in the opposite direction, the eyeball being fixed with forceps, and an incision is made in the conjunctiva about 2 mm. from the limbus and parallel to it for about 10 mm. (fig. 5 *A, i*). At either end and perpendicularly, two other incisions, *a* and *b* about 8 mm. long, are cut. The resulting quadrangular flap, *f*, is raised and undermined until the sclera is completely laid bare and reclined. To obtain a maximum

rotation of the eyeball and facilitate the operation, a fixation suture, *d*, is passed through the corneal lip of the conjunctival wound, immediately before the dissection of the flap. This suture is held by forceps and anchored at a convenient place for a maximum effect. After the sclera

Fig. 5.—Operative technic of cyclodialysis with implantation of magnesium in the human eye. *A* shows the retaining suture, *d*, fastened to an incision, *i*, parallel to the limbus. Lateral incisions perpendicular to *i* are indicated by *a* and *b*. The conjunctival flap, *f*, is raised up and reclined. The preliminary sutures, *s*, are shown going through the conjunctiva and the flap. The scleral incision whose site has been determined at 8 mm. from the limbus by the caliper, *cc* (shown in dotted lines), is indicated by *g*. *B* shows the cyclodialysis spatula detaching the ciliary body from one side to the other of the limbus. *C* shows the carrier, *h*, already containing the magnesium implant, *m*, inserted inside of the wound. When the tip shows in the anterior chamber, the carrier is withdrawn, while at the same time the button, *c*, is pushed down, thus keeping the metal in place. *D* shows the conjunctival flap, *f*, lowered and attached to the lips of the incisions by the preliminary sutures. The magnesium implant, *m*, appears (for demonstration purposes) through the conjunctiva and the sclera. The tip in the anterior chamber is surrounded by numerous bubbles of hydrogen.

has been well dissected, all hemorrhage should be stopped either by pressure or by actual cauterization of the scleral veins, which are often dilated in cases of glaucoma. If this is not done, blood will be sucked through the wound into the anterior chamber as soon as this is reached. It is important to determine the exact site of the scleral incision, as the implant has a certain length and should when in situ protrude only about 1 mm. into the anterior chamber. For this reason the scleral cut has to be made about 1 mm. shorter than the implant. The length of this being usually 8 mm., the sclera should be divided at 7 mm. from the corneal margin. In order to determine the exact location, a caliper (fig. 5 *A*, cc in dotted lines) should be employed, the point being placed in the limbus and the cutting edge at 7 mm. behind. The sclera is then divided at *g* with a Graefe knife or with some other narrow knife, the blade always being kept at a right angle with the surface of the eyeball. The tissues are sectioned carefully layer by layer, until the resistance diminishes and the uvea is seen through the wound; great care should be taken not to injure the ciliary body or the choroid, which lie immediately beneath.[17] A cyclodialysis spatula is then introduced into the wound and carried forward between the sclera and the ciliary body (fig. 5*B*). The tip is always kept pressed against the lower surface of the sclera and pushed forward until it ruptures the insertion of the ciliary body at the scleral spur and penetrates into the anterior chamber. When the rounded end is seen beyond the limbus (fig. 5 *B*), lateral movements are made to the right and left to detach the ciliary body the whole length of the incision. If the ciliary body is not injured, no bleeding appears in the anterior chamber. The spatula is then withdrawn, and the scleral incision is enlarged with scissors at each side. The purpose of this widening is to have more space for the carrier (fig. 2), which is thicker than the spatula. With the magnesium double strip already fitted in its groove (fig. 5 *C*, *m*), the carrier is inserted through the wound until its tip appears in the anterior chamber. Care should be taken during the introduction of the carrier to keep it hugging closely the inner surface of the sclera. When the metal is in place, the carrier, *h*, is slowly withdrawn, while at the same time the pusher inside of the handle is pressed forward to keep the metal in place and prevent its coming out. If there is any tendency to this, the tip of a forceps should be kept pressed against the protruding end until the conjunctival flap (fig. 5 *D*, *f*) is lowered, spread flat and sutured at each corner and at the middle of the long conjunctival incision. A dressing and a slight compressive bandage are then applied.

17. Instead of the incision, a scleral trephining can be done. According to Sallmann it is easier and entails less risk of injuring the uvea. Del Barrio has recorded cases of uveal hernia and late infection.[3]

Preparation of the Implant.—Chemically pure magnesium can be obtained on the market in narrow ribbons. From these the implant may be cut off with strong scissors and measured with a millimeter scale. A strip 1 mm. wide and 16 mm. long is severed, folded tight in two and then bent squarely at the middle for about 0.5 mm. (fig. 2, *2*). Two independent strips each 8 mm. long may also be prepared, the tips being bent together squarely on one side.

To avoid the sharp edges that may be left in the metal by the scissors, the implant should be dipped in a 5 per cent solution of acetic acid and immediately changed to pure water. It is then placed inside small glass tubes plugged with cotton and sterilized for two hours in the oven at 170 F.

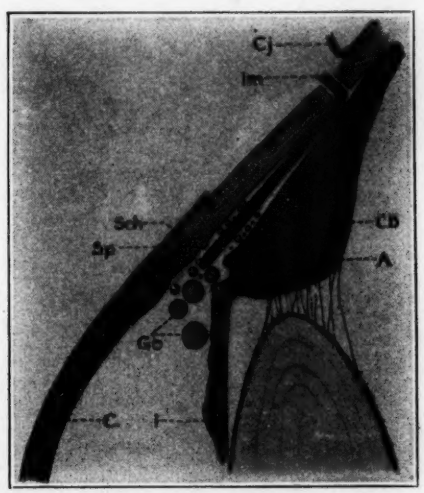


Fig. 6.—Semischematic representation of the angle of the anterior chamber and the vicinity showing the cyclodialysis operation with implantation of magnesium in an eye with an open angle. The ciliary body, *CB*, has been already detached from the sclera as far as the scleral spur, *Sp*. The point *A* shows the insertion of the ciliary body opposite to the spur. *Sch* indicates Schlemm's canal; *C*, the cornea; *I*, the iris, and *Cj*, the conjunctiva. The magnesium implant, *Im*, is already in place, and its inner tip reaches the anterior chamber just beyond the insertion of the ciliary body. The outer end is bent square to avoid it from sliding into the anterior chamber and also for raising the conjunctiva. Gas bubbles, *Gb*, of different sizes are shown in the anterior chamber and along the tunnel made by cyclodialysis.

When the strip is to be used it is removed from the tube and placed inside of the groove of the carrier with a forceps. Fitting and keeping it in the groove proved difficult at first. The magnesium is so light that any small movement can displace it. To avoid this trouble, all that is necessary is to dip the carrier in water or saline solution. The strip will then stick easily and remain in place.

Choice of Site for Operations.—Although the implant can be deposited at any place around the limbus, to obtain better results it is desirable to examine the angle previously with the gonioscope and find out if there is a spot where the angle is open. In this location the spatula has to break through only the lineal attachment of the ciliary body to the scleral spur (fig. 6 from *Sp* to *A*), while in case of peripheral synechia the spatula has to detach the whole breadth of the peripheral synechia (fig. 7, from *Sp* to *Sy*). If the angle is open, the magnesium strip can keep the surface from *Sp* to *A* more easily separated and obtain a permanent aperture at the insertion of the ciliary body than in the case of a peripheral synechia, in which the cicatricial tissue from *Sp* to *Sy* has a greater tendency to reattach both surfaces to each other.

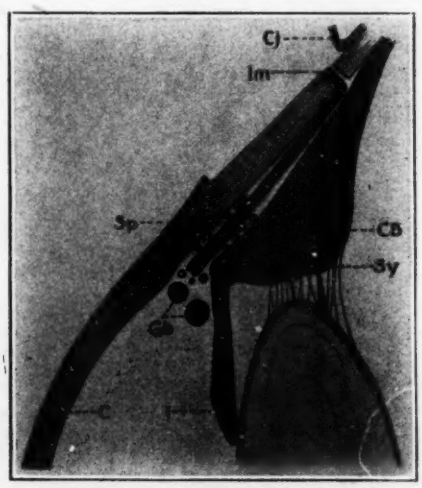


Fig. 7.—Semischematic representation of the metal implant in a case of anterior peripheral synechia. *C* indicates the cornea; *I*, the iris; *Sp*, the scleral spur, and *Sy*, the anterior synechia detached from the cornea by the spatula beyond the site of Schlemm's canal, which is obliterated. Only remnants of the trabecular tissue remain. The implant, *Im*, reaches the anterior chamber through the whole breadth of the synechia. Its tip instead of being rounded as in the previous figure is made by the end of two different strips, one above the other. Gas bubbles, *Gb*, are shown in the anterior chamber and the tunnel of the operation.

Complications.—The most important accident during the operation is the loss of vitreous, which should be carefully avoided. If, however, the loss is small, the implant can be introduced as usual, as its contact with the vitreous has no danger for the eye. Detachment of Descemet's membrane is a frequent complication, as shown by gonioscopic examination. It is to be suspected when a great resistance is felt to the advance of the spatula as it nears the limbus. The instrument should then be slightly withdrawn and the forward movement continued. Hemorrhage

in the anterior chamber is to be avoided, as the presence of blood may favor reattachment and change the character of the postoperative scar. The conjunctival flap covering the implant is sometimes so much raised by gas that sutures may be broken and the metal exposed. In that case a new suture should be immediately applied.

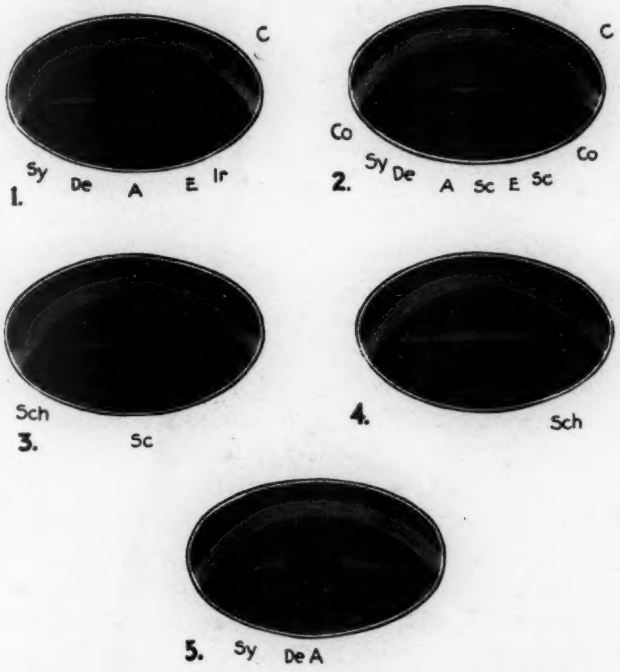


Fig. 8.—Gonioscopic pictures of the angle of the anterior chamber.

In *1* is shown the gonioscopic picture of the right eye in case 5. *C* indicates the cornea; *I*, the iris; *De*, Descemet's membrane; *A*, the aperture left by the implant after absorption; *Sy*, the anterior peripheral synechia, and *E*, the attachment of some fibers of the iris to the cornea.

In *2* is shown the gonioscopic picture of the angle of the left eye in case 5. The letters have the same meaning as in the previous figure. *Sc* indicates a discolored band of the sclera from which the peripheral synechia was detached.

In *3* is shown the gonioscopic picture of the angle of the right eye in case 6 thirty-six days after operation. Above the coloboma and the edge of the iris there is a yellowish pigmented band which is the Schlemm, or trabecular, band. Inside the coloboma the spatula has detached the ciliary body, which receded, exposing a yellowish band of the sclera, *Sc*.

In *4* is shown the gonioscopic picture of the same angle fifty-three days after the operation. The ciliary body has reattached itself to the edge of the Schlemm zone, obliterating the aperture.

In *5* is shown the gonioscopic picture of the angle of the anterior chamber in the temporal side of the same eye as in *4* after the second operation on the temportal side. *A* indicates a fissure at the iris edge of the peripheral synechias, and *De*, Descemet's membrane, detached and ruptured.

Postoperative Course.—A few minutes after the insertion, the implant is covered with small bubbles (fig. 5 *D*), which later coalesce, forming large gas spaces which fill in part the anterior chamber. It is well known that simple cyclodialysis produces a reaction in the eye with ciliary injection and even the formation of posterior synechia. The presence of the foreign body increases this reaction, so that the eye remains red for some days after the operation. Occasionally, nervous patients feel some pain at night. The bubbles of gas increase for two or three days and then diminish in size and slowly disappear. Usually there is also gas under the conjunctival flap, which is raised and remains congested for several days. In some cases I have observed with the ophthalmoscope bubbles of gas into the vitreous. They appear near the operative wound as round black bodies with a clear and shining center. The intraocular tension is usually kept lower during all this period by the oozing of aqueous through the scleral aperture. At the end of the second week the eye is usually quiet, the conjunctival flap is entirely healed and no traces of gas or of the implant are visible. Physostigmine salicylate should be instilled at this time or a little earlier to pull the iris root down. Massage has to be started at the end of the second week to keep patent the passage through the lacunar tissue of the scar. The intraocular pressure may rise when the scleral scar is healed, but after some variations it comes down to a normal level. In some cases, however, especially when the cyclodialysis detaches a peripheral synechia or when the amount of metal implanted is small, hypertension may recur. If this happens, new implantation operations can be made in any other part of the limbus, as the method is innocuous for the eye. There is a contraindication, however, to the use of the implant when a previous iritis or cyclitis has run its course. In case 7 in which an old interstitial keratitis was present, the implant rekindled the old cyclitis. Fortunately, this subsided in three weeks, but the effect of cyclodialysis was lost.

CLINICAL HISTORIES

The following clinical histories are especially a report of the results of magnesium implantation. No attempt will be made to describe in detail the history of each case previous to the use of the implant, except when necessary for a better understanding of the course of treatment.

The number of operations performed to date is twelve. Of these, two were performed on the same eye in case 6. The first one was done sixteen months before this paper was written (case 1), and its good results are still apparent in the normalization of tension.

To appraise the usefulness of implantation, it should be borne in mind that in all cases except 4, 6 and 7 operation had been done several times before by other methods, with poor results. Only when the

magnesium is used in more numerous and better selected cases and the follow-up study extends over a longer period will one be in a position to determine the permanent value of magnesium implantation.

A magnesium implant was first used in blind eyes with absolute glaucoma, and when its easy absorption and harmlessness were proved, it was used in seeing eyes affected with different kinds of glaucoma.

CASE 1.—Mr. H. Z., aged 62, came to the hospital suffering from absolute glaucoma of the left eye and chronic simple glaucoma of the right eye. A trephine operation had been done on the left eye one year before, which did not improve the condition, vision failing steadily. A trephine operation had been done on the right eye on Jan. 25, 1938. When the patient was seen at the clinic in February 1938, the left eye had only perception of light and was red and painful. Tension was 47 mm. Vision in the right eye was 20/20 with correction and tension was 23.

Gonioscopic examination of the left eye showed in the upper angle a partial operative coloboma filled with a white mass of exudate and newly formed vessels. The pupil was drawn upward, and the uveal layer of the iris turned out in a large ectropion. The rest of the angle was open nasally, temporally and downward. In the right eye the anterior chamber was deep and the angle was widely open all around the limbus except at the site of the trephining, where there was an adhesion of the iris to the scleral scar with a drawn up pupil and dislocation of the processes forward. On account of the pain, a second trephine operation was done on the left eye on February 8. This also failed to control the tension, which on April 15 was 40 mm. Cyclodialysis with implantation of magnesium was then performed on the left eye on April 26, a single strip of magnesium 8 mm. long and 2 mm. wide being inserted to the temporal side of the first trephining. The next day the eye had some reaction, one large bubble of gas appearing in the anterior chamber. On April 30 there was a little blood in the aqueous. The conjunctival flap above showed a small hemorrhage. No pain or discomfort was felt. There was no sensitiveness on pressure. On May 2 the reaction subsided. There was still a big bubble in the anterior chamber. Tension was 30 in the left eye and 40 in the right eye. Roentgen examination of the eyeball was made by Dr. R. Pfeiffer to locate the metal (six days after the operation). Stereoscopic films of the orbits projected in the usual way did not show the implant, but free films of the anterior segment of the eye detected nicely a linear shadow approximately 5 mm. long connecting with a large collection of gas in the anterior chamber. On May 6 the eye was quiet. The hyphema was almost absorbed. Two small bubbles of gas floated in the anterior chamber. Tension was 26 in the left eye and 35 in the right eye. On May 13 the eye appeared normal. No bubbles or blood could be seen in the anterior chamber. Tension was 21 in the left eye, while in the right it was 35. Roentgen examination was repeated on this day and bone-free films of the anterior segment showed no evidence of the metallic implant or gas in the anterior chamber. Gonioscopic examination was repeated on May 20. At the site of the implant there was a white atrophic patch in the iris with vessels which spread over to the vicinity. No aperture or slit was seen in the angle at this place. The white mass at the old coloboma was still present. In November 1938 the left eye continued to have low tension and was comfortable, while the right had intervals of pain and high tension, rising to 40. I decided then to operate on the right eye, using cyclodialysis and a magnesium implant. This was done on Jan. 20, 1939. A single strip of magnesium was placed at the upper part about 12 o'clock. Two drops of vitreous were lost. Two days later the eye had little

reaction, but some blood appeared on the surface of the iris. There was a bubble in the anterior chamber. On January 25 the hyphema was reduced, the pupil was contracted and there were no bubbles in the anterior chamber. Under the conjunctival flap gas was collecting, raising it considerably. On January 31 there was still slight hyphema. At this time the pupil was dilated with atropine and showed two small posterior synechiae. Tension varied from 20 to 22. On February 2 gonioscopic examination of the right eye showed a broad black line at the site of the implant, probably an aperture through the ciliary body, to which was adherent a piece of twisted, curved iris tissue. The rest of the angle was open as before. From this time on tension was kept low in both eyes with slight variations (19 to 25). Vision in the right eye was 20/30 with correction. The patient is comfortable and works steadily.

Comment.—This case shows the excellent and durable effects in the normalization of tension in two eyes with an open angle.

Case 2.—Mrs. S. M., aged 68, came to the hospital suffering from absolute glaucoma in the right eye. A cataract operation had been performed on the right eye three years before, and vision remained good for about one year. Then pain developed, and a trephine operation was performed. When the patient was seen at the clinic in April 1938 vision was reduced to perception of light and tension was 75+. The left eye was normal, with vision of 20/20, a peripheral opacity of the lens and tension of 20. Cyclodialysis with implantation of magnesium was performed on the right eye on April 26. A single strip of magnesium 8 mm. long was introduced. The next day the eye had a slight reaction; the anterior chamber was filled with bubbles of gas in the upper part. On April 29 there was a moderate reaction but no pain or discomfort; the pupil was contracted, and there were bubbles as before. On May 2 there was little reaction. There were still two bubbles of gas in the anterior chamber; the conjunctival flap was open in front, being raised by bubbles. On May 4 there was slight pain, and a little hemorrhage appeared on the surface of the iris. A bubble remained in the anterior chamber. Roentgenograms of the eye were taken by Dr. R. Pfeiffer on May 4, one week after the operation. They showed on bone-free films of the anterior segment a faint curvilineal shadow of increased density, minute and connected with a small collection of gas above the eye. On May 13 roentgen examination showed no evidence of the metal implant or of gas in the anterior chamber. The eye was normal, the cornea was clear and the fundus was visible. There was some perception of light in the temporal field. Tension was down to 36. On May 20 tension was the same, but the eye was quiet and no longer painful. The patient, a very nervous woman, was greatly disappointed not to recover her sight in the eye and did not want to come back to the clinic or be examined.

Case 3.—Master W. W., 3 years old, was seen at the hospital with a diagnosis of congenital glaucoma in each eye. Trephining with iridectomy had been done on each eye May 2 and 11, 1936. One year later trephining was repeated in the right eye, and the tension remained high. Cyclodialysis was done on June 20, 1938. The condition did not improve. The cornea being turbid and the eye painful, I performed cyclodialysis with implantation of metal in the right eye on November 22, inserting a double strip of magnesium on the upper part at the side of the closed trephine hole. No bubbles of gas were seen in the anterior chamber. They accumulated under the conjunctiva, raising the flap. Healing was uneventful, and on December 2 the eye was entirely quiet, the cornea was transparent and the conjunctiva was normal. On December 16, twenty-four days after operation, there

was still a small bubble in the vitreous. The fundus was clearly visible, the cornea was clear and tension was apparently normal to touch. The same condition continued until March 30, 1939.

Comment.—The results of the implantation done after two trephine operations and one simple cyclodialysis which had failed were considered good, as the congestive signs disappeared from the right eye and the child was comfortable. Unfortunately, the use of the tonometer was impossible without a general anesthetic.

CASE 4.—M., aged 11 months, had congenital glaucoma in each eye. Her sister has buphthalmos. The parents brought the child to Dr. G. M. Bruce for examination, and under ether the tension was found to be 34 in each eye. No treatment had been given before. The corneas were large and steamy and the anterior chambers deep. On April 5, 1939, implantation was done in each eye, that in the right eye by Dr. Bruce and that in the left eye by myself. Two strips of magnesium 8 by 1 mm. were inserted in the right eye, while only one strip of the same size was used in the left eye. The results of the operations were good. The eyes did not show great reaction, especially the left, in which a less amount of metal was used. Large bubbles of gas were present in the right eye two days after the operation and continued for three or four days more; then they disappeared. Healing was uneventful, and tension became low to touch. The corneas cleared up.

Comment.—As in case 3, the results were considered good, as the corneas cleared and the tension came down. Further observation is necessary to determine if the results are permanent.

CASE 5.—Mr. B. R., a Negro aged 52, came to the hospital for treatment of chronic noncongestive glaucoma in both eyes. A trephine operation with peripheral iridectomy upward had been done on the left eye on Jan. 21, 1938. As the hole closed and tension rose again, cyclodialysis with iridectomy was performed at about 3 o'clock on October 10. A trephine operation with complete iridectomy was done on the right eye in June 1938. After a period of normal tension, the tension rose again, and a second trephine operation was performed. In November hypertension returned. I examined the patient in December 1938, and on December 7, at my suggestion, Dr. Daniel B. Kirby performed cyclodialysis with a magnesium implant in the right eye between 8 and 10 o'clock. A single strip of magnesium 8 mm. long was inserted, the new carrier being used. The tip of the metal appeared in the anterior chamber and immediately was surrounded with small bubbles of gas. On December 9 the eye was quiet. There were no bubbles in the anterior chamber. On December 14 the reaction was mild. Two bubbles appeared in the anterior chamber. No pain or discomfort was felt. On December 16 the reaction had subsided. The conjunctival flap was raised by bubbles, and on December 23 a slight hemorrhage appeared on its surface; otherwise the eye was normal. The fundus was clear, and tension varied between 17 and 20. On Jan. 6, 1939, the conjunctival flap was still raised. The anterior chamber was normal. Gonioscopic examination showed at the site of the implant a hole or separation of the iris from the sclera (fig. 8, *1, A*) and on one side of it a detachment of Descemet's membrane (*De*), which appeared as a white, semitransparent film, raised over the level of the iris. On the side of the aperture there was a small anterior synechiae (*E*) made of a few fibers of the iris attached to the cornea. Nothing similar existed in any other part of the angle, which was closed all around.

The left eye was operated on and a magnesium implant inserted by Dr. Kirby on January 10. After incising the conjunctiva above and temporally, he opened the sclera with a 2 mm. trephine instead of with a knife. A single piece of magnesium 1 mm. wide and 8 mm. long was inserted with the carrier. After the operation there was considerable reaction, with bubbles in the anterior chamber and hyphema. There was edema of the lids. On January 13 the reaction was still marked, and there was some pain in the eye. No blood or bubbles of gas appeared in the anterior chamber, but the conjunctival flap was greatly raised by gas. On January 14 a large bubble appeared in the anterior chamber. The reaction subsided. Typhoid-paratyphoid vaccine was injected. On January 18 there was still a bubble of gas in the anterior chamber. The reaction had almost disappeared. On January 20 the eye was quiet. The fundus was clear, and the disk was visible. On January 22 the eye appeared normal, but tension was high (35). Massage and physostigmine salicylate were used. The patient was discharged and came to the clinic on January 27. Tension was 40. An upset stomach and nervous trouble had affected his eyes. On February 10 tension varied between 38 and 40 after massage. The eye was quiet, and there was no pain. The patient considered himself much improved. Gonioscopic examination of the left eye at the site of the implant about 2 o'clock showed (fig. 8, *2*) that Descemet's membrane (*De*) had been detached and formed a triangular white membrane raised on the level of the iris. The old peripheral synechia (*Sy*) was detached from the cornea (*Sc*) and depressed from the level of the old insertion of the iris, where a broad, black, slightly irregular line appeared. This probably was the opening of a communicating fissure between the anterior chamber and the suprachoroidal space. On March 15 the tension varied between 35 and 30. Up to the time of writing both eyes have remained quiet. Vision in the right eye was 20/30 with correction and in the left 20/50. The field of the left eye showed a small central island of vision extending to 10 degrees. The field of the right eye revealed a slight peripheral contraction. The blindspot was enlarged.

Comment.—In this case both eyes had been operated on twice without benefit. The angle was closed by complete peripheral synechia in both eyes. Implantations have removed all signs of congestion and lowered the tension to 30 to 35 mm. They can be repeated if necessary. The well known resistance to treatment of glaucoma in Negroes should be also considered.

Case 6.—Mrs. E. S., aged 56, came to the Institute to be operated on for senile cataract on the right eye. Combined intracapsular extraction was done on June 18, 1938. Her condition remained normal until pain and redness appeared. A diagnosis of iridocyclitis and secondary glaucoma was made. Tension was 36 in the right eye and 18 in the left eye. Atropine was used, and the eye improved. On August 23 tension rose again to 30. The anterior chamber was shallow, and the temporal pillar was incarcerated at the scar of operation. On September 27 a trephine operation with iridectomy was done at 6 o'clock, with improvement of symptoms. On October 24 there was again severe pain in the right eye, and the tension rose high. The patient was readmitted to the hospital with the diagnosis of acute glaucoma. Under physostigmine salicylate, the tension came down. On October 25 I performed cyclodialysis with implantation of magnesium at the upper part of the limbus. A single strip of magnesium 8 mm. long was inserted with the carrier. Two drops of vitreous escaped. The next day the eye had con-

siderable reaction, with a few bubbles of gas in the anterior chamber. The fundus appeared normal with the ophthalmoscope. On November 4 the reaction had diminished a great deal and the pain had subsided. On October 30 the anterior chamber was still shallow. The conjunctival flap was redder than before and raised by gas. With the ophthalmoscope two small bubbles of gas were seen behind the lens. There was little reaction. On October 31 the tension was 35 mm. The patient was discharged on November 2, with gas still present in the vitreous and underneath the conjunctival flap. On November 16 vision was 3/70 with correction.

On November 30 gonioscopic examination of the right eye showed at the site of the implant inside the coloboma of the iridectomy two bands (fig. 8, *3*); the upper one was highly pigmented: the Schlemm, or trabecular, band (*Sch.*). Underneath there was a discolored yellow-red band (*Sc*) due to detachment of the ciliary body, which had shrunk, leaving the sclera uncovered. On December 7 the eye was again red and painful, and tension was 35 mm. To provide another way for escape of aqueous and to reduce the tension more, a second cyclodialysis with implantation of magnesium was done between 10 and 8 o'clock on December 13, this time by Dr. Kirby. Three days later there was some reaction but no pain. The cornea was clear, and the anterior chamber was filled with numerous bubbles of gas. A slight hemorrhage appeared in the anterior chamber. The implant was surrounded by a thin whitish membrane. On December 20 the patient was discharged with some bubbles still in the anterior chamber. The use of physostigmine salicylate, massage and hot applications was instituted. The eye was quiet, the fundus clear and the disk visible. Gonioscopic examination on Jan. 23, 1939 (fig. 8, *4* and *5*) showed that the yellow discolored band was no longer visible at the site of the first implant (fig. 8, *4*). The ciliary body had raised and reattached itself to its former location in the sclera. On the other hand, in the temporal side at the site of the second implant (fig. 8, *5*) there was a definite fissure or notch (*A*) at the iris edge of the peripheral synechia. This notch was black, and the borders were continuous on each side with the border of the synechia. Above the notch was a whitish membrane—the detached and ruptured Descemet's membrane. The tension from the second operation to the time of writing has oscillated between 30 and 35 mm.; vision is 20/30 with correction. The eye is comfortable and the fundus clear.

Comment.—In this case of acute glaucoma following cataract extraction and iridocyclitis a trephine operation not only failed to arrest hypertension but was followed by an acute attack, probably due to closure of the hole. A magnesium implant was inserted inside the area of the coloboma above with definite diminution and then subsiding of pain. However, hypertension returned, and a second implant was inserted in the temporal side and downward, detaching a peripheral synechia. Gonioscopic examination showed that a communication probably exists between the anterior chamber and the suprachoroidal space. Under the conjunctiva a bluish depressed spot remains at the site of the implant. Tension in April 1939 varied from 30 to 35.

CASE 7.—Mrs. G. L. came to the hospital for treatment of deafness and also complaining of progressive failure of vision. During her infancy she had suffered severe interstitial keratitis due to congenital syphilis, which had left her corneas cloudy. Lately she saw halos around the lights and had pain, nausea and dizziness.

Tension was 47 in both eyes and increased in spite of the use of miotics. The corneas were cloudy and the anterior chamber shallow. Vision in the right eye was 20/70 with correction and in the left eye 20/200 with correction. Gonioscopic examination could not be made on account of the haziness of the membranes. I performed an implantation operation on February 21 on the right eye, inserting a double strip of magnesium 8 mm. long. Three days later the eye had a moderate reaction; several bubbles of gas appeared in the chamber. On February 25 the eye was quiet. There were some pain and tenderness in the ciliary region, and bubbles of gas still remained in the chamber. On March 1 the reaction suddenly increased, and the eye became red and painful. The conjunctival flap was raised by gas. The next day the eye was sensitive on pressure above. Cyclitis developed, the foreign body probably awakening a dormant inflammation of the ciliary body, complicating the interstitial keratitis due to congenital syphilis. Injections of bismuth subsalicylate were immediately started and also of typhoid-paratyphoid vaccine. These controlled the condition promptly, and two weeks later pain and inflammation had subsided. Hypertension returned, the tension measuring 50. The cyclitis probably obstructed the aperture made in the synechia by the operation. As the patient was compelled to return to her home at a great distance from New York, a trephine operation was done on March 14. The reaction was also marked after this operation, but the injections of bismuth salicylate were continued and the inflammation subsided. The patient was discharged with tension of 26 mm.

Comment.—This case is interesting as it shows that the implantation should not be done when it may awaken an inflammation dormant in the ciliary body and when systemic conditions exist that may favor great inflammatory reactions.

Case 8.—Miss M. D., aged 54, was admitted to the institute on Nov. 4, 1938, with a diagnosis of chronic noncongestive glaucoma in the right eye. Three days later she had an attack of acute glaucoma, with nausea, vomiting, swelling of the lids and loss of sight; tension was 60. The pupil was dilated and inactive, and there was some exfoliation of the lens capsule. With the use of physostigmine salicylate tension came down to between 17 and 15 and vision improved to 20/200. Gonioscopic examination of the right eye showed the anterior chamber to be shallow. There was a peripheral synechia on the nasal side, but the rest of the angle was open around the limbus. In the left eye the angle was open all around. Cyclodialysis with implantation of magnesium was done by Dr. Kirby on November 22, two strips 1 by 8 mm. being inserted at 12 o'clock. After the operation there was a mild reaction with numerous bubbles of gas in the anterior chamber and a slight hyphema below; headaches occurred at night. Four days later the conjunctival flap was raised and hyphemic. One week after operation tension was 10. The eye was quiet. The patient was discharged. On December 2 the reaction had disappeared, and the hyphema was absorbed. The pupil was round and slightly displaced upward and showed two posterior synechiae. The conjunctival flap had a small hemorrhage in the stroma of the membrane. Atropine was instilled. On December 7 the eye was quiet; a small bubble of gas still remained in the anterior chamber. Tension was 7. The fundus could be easily seen except for a slight opacity of the lens which had existed previous to the operation. On December 21 tension rose to 27, with the eye entirely normal. Instillation of a 2 per cent solution of pilocarpine hydrochloride and massage were

started. On January 15 the tension came down to 22. Vision was 20/40 with correction. On January 23, two months after operation, gonioscopic examination showed that a notch was present on the edge of the iris at the site of the implant which extended for about 4 or 5 mm. toward the nasal side (similar to the one in figure 8, *5*). The abrupt side of the notch was continuous with the level of a peripheral synechia, while the other side showed a gradual depression. This fissure probably was the entrance to the suprachoroidal space. On February 17 tension was 22. The same condition persisted for the whole month of February, but on March 10 tension rose to 30 in spite of massage and the use of physostigmine salicylate. At the time of writing the eye is in good condition. The patient is comfortable. Tension is normal.

Comment.—In this case after a subacute attack of glaucoma the angle was still open in three sides. The first operation consisted of insertion of the implant and was performed above where the angle was free. The results have been good. The reaction was not marked. Tension remained subnormal for one month and then slowly rose to 25 mm., 30 mm. and 25 mm.

SUMMARY

To improve the results of cyclodialysis in the treatment of glaucoma, I have implanted a strip of magnesium in the wound between the ciliary body and the sclera. Magnesium is absorbed by the tissues, giving off bubbles of free hydrogen, in about twenty days. The presence of the metal and the bubbles of gas prevent the reattachment of the ciliary body to the sclera, thus affording a new way for the outflow of the aqueous to the perichoroidal space. Experiments with animals and microscopic sections have shown that a lacunar scar is formed between the anterior chamber and the suprachoroidal space, ending in a thin scleral cicatrix. No complete channel was ever found.

Implantation of magnesium after cyclodialysis was made in 12 human eyes with subacute, chronic congestive, simple or congenital glaucoma. There was at first a mild reaction to the foreign body, with numerous bubbles of gas appearing in the anterior chamber and under the conjunctiva. The reaction subsided in about one week, and the metal was entirely reabsorbed at the end of twenty days. Clinical results have been good in the majority of cases; in others, there was improvement with diminution of hypertension, and in 1 case no improvement occurred. The method is harmless and can be repeated several times in the same eye.

Dr. Daniel B. Kirby permitted me to operate on some of his clinical and private patients; Dr. Gordon M. Bruce gave me permission to operate on the patient in case 4; Drs. Algernon B. Reese and Charles A. Perera helped with the histologic examinations and Dr. Eduardo Gallardo assisted in the research work.

500 West End Avenue.

ABSTRACT OF DISCUSSION

DR. OTIS R. WOLFE I, Marshalltown, Iowa: This is a real scientific contribution with clinical experience supported by research. Dr.

Troncoso demonstrated several cases to me that were most convincing, and I expect to try his technic at the earliest opportunity.

The experience of my associates and me has been limited to clinical application of the seton operation and largely in cases of severe glaucoma and of glaucoma occurring in aphakic eyes. In aphakia following cataract extraction nature is lavish in her healing process. The ciliary body is prone to throw off an excess of healing substances, particularly fluids. If the function of drainage is impaired, it is not able to take care of this excess, even though under more nearly normal conditions it might do so. Magitot has stated that hypertension is one thing and glaucoma another. I am more and more impressed that primary glaucoma is a systemic condition manifested in the eye. One is, however, confronted with the necessity of draining off the excess of fluid to keep the tension down. This is particularly true after a capsulotomy cataract extraction. Undoubtedly anaphylaxis of the lens partly explains this, but not to my entire satisfaction. A rise of tension or glaucoma occurs much less frequently after intracapsular extraction. I believe that this presents one of the big arguments in favor of this type of extraction.

After cataract extraction, when the healing hyperemia is prolonged if iritis develops there is an excess of intraocular fluid with a rise of tension. From observation of unsatisfactory results obtained after cataract extraction, one can most often discover the presence of glaucoma. Cataract and glaucoma frequently coexist, but the glaucoma is more often overlooked. Intracapsular extraction of a growing or intumescent lens is not infrequently indicated to control glaucoma. Study of cases in which fair to good vision has been obtained and then lost, except when a membranous cataract had been the problem, usually revealed glaucoma. In cases in which needling has been done and part or all of the vision lost glaucoma has also been frequently demonstrated.

These problems led my associates and me to search for a method of relieving tension when the amount of fluid was too great to be relieved by iridectomy or trephine operations. Cyclodialysis giving suprachoroidal drainage was the technic that impressed us most after trying iris inclusion. We performed the Mauksch-Suker technic several times in cases of aphakic glaucoma, and the results were good except for two severe late hemorrhages that spoiled good surgical procedures. We inserted a silk seton at cyclodialysis in 1 case. Progress was satisfactory until three months later, when the patient died suddenly as the result of a heart attack. We have employed the seton in about 40 cases with fairly satisfactory results. Dr. Troncoso's technic appears to give permanent drainage into the suprachoroidal space without the disadvantage of a permanent foreign body.

In our earlier studies we found that when performing an iris inclusion operation in an aphakic eye the best results were obtained when the capsule was incarcerated along with the iris. It then occurred to us that the capsule was probably acting as a seton, as reported by me in an article in the *American Journal of Ophthalmology* in 1931 (**14**: 769, 1931). In one of the cases of glaucoma which followed intracapsular cataract extraction neither an iris inclusion operation nor two Elliot trephine operations kept the tension down. The patient had only one eye. We then performed our seton technic, and the seton is still in place after six and one-half years. The patient's general health at 80 is poor, but a report last week stated that she is still able to read.

We have had other cases in which the seton has been in place a year or more with varying results, but in the main they are favorable, considering the severity of the condition. At first the seton operation was considered as an emergency measure and last resort, but I now believe that it may prove to have a wider degree of usefulness. I do not, however, know about all the end results.

Dr. Troncoso's method may prove a more satisfactory means of lowering high tension. Cyclodialysis, if it could be made permanent, always impressed me as the most nearly ideal technic. I believe Dr. Troncoso's method of obtaining permanent cyclodialysis bids fair to revolutionize surgical treatment for glaucoma, especially when excessive fluid is produced, and perhaps for other types as well. It should be good for the noninflammatory type with a high tension range. I know from my nine years of experience with the seton technic that the eye will tolerate a foreign body surprisingly well. Even with the through and through seton operation which Dr. Blaess and I described in the *American Journal of Ophthalmology* (**19**: 400, 1936), the iris shows no intolerance to the foreign body. However, if the seton protrudes through the conjunctiva it causes irritation and discomfort. It is, therefore, important that the seton be covered with water tight sutures and have a perfect closure, as in Dr. Troncoso's method.

Hemorrhage has been the great problem in aphakic eyes. I operated in 2 cases at Green's Eye Hospital in San Francisco in which the condition was so severe that enucleation was contemplated. One eye later was enucleated on account of hemorrhage after a satisfactory surgical procedure. I imagine that the same problem of hemorrhage will be present in certain cases in which Dr. Troncoso's procedure is utilized. I concur with Dr. Troncoso as to the advantage of checking episcleral hemorrhage by cautery, but secondary hemorrhage will occur in a certain number of cases. This is especially true in the aphakic eye.

The multiplicity of glaucoma technics shows that a wholly satisfactory technic for all kinds of glaucoma has not been found. One must always make a careful analysis of the particular case at hand. For the low grade noninflammatory type I shall for the time being favor the Elliot trephine operation, using the Green automatic instrument. I shall, however, consider the substitution of Dr. Troncoso's technic where it seems applicable. If lenticular changes are present so that a cataract extraction is likely to be required later, I shall do an iridectomy with the trephine. However, if I have a case in which there are marked ciliary hyperemia and high tension showing a high production of fluid, I shall now consider Dr. Troncoso's technic or the seton operation, where formerly I should have relied on iridectomy or iridencleisis. The seton technic is now my operation of choice in glaucoma of the aphakic eye. The eye that bleeds easily has nullified several otherwise satisfactory surgical results with the seton. Two other eyes were enucleated because of late hemorrhage into the vitreous in aphakic eyes. Only one eye was lost from infection. My associates and I have set up some more or less definite indications for the two different types of seton operations. The through and through seton is favored if the pupil can be contracted, if there is not much plastic exudate, if the iris is not

atrophic, if the anterior chamber is not too shallow and if the eye is not highly congested. In the other cases, the loop seton is favored. We also now combine with the seton a small sclerectomy with the Holth punch.

DR. MANUEL U. TRONCOSO, New York: I want to emphasize that when the first implantation operation does not succeed it can be repeated several times, as it is harmless.

The condition of the angle before the operation has much to do with the final result and should be thoroughly investigated.

TREATMENT OF SECONDARY GLAUCOMA

SANFORD R. GIFFORD, M.D.
CHICAGO

When I was asked to discuss the treatment of secondary glaucoma, I felt, in spite of the miscellaneous variety of conditions included under the name, that it might be of some practical use to review a group of cases with emphasis on a few types of glaucoma for which the treatment is by no means standardized. My series is taken chiefly from private records during the past ten years, since in a fair proportion of these cases treatment could be carried out under uniform conditions and with observation of the end results. Some cases were observed only in consultation or in the course of a "shopping tour," and in these no observations as to treatment are available; so they are mentioned only in table 1.

This table indicates the causes of secondary glaucoma in my series. I have not attempted to ascertain the incidence of secondary glaucoma among all cases of glaucoma in this limited series. Lehrfeld and Reber,[1] among 1,876 cases of glaucoma of all kinds, classified 413, or 22 per cent, as secondary. Trauma accounted for the largest number in their series (101), while uveitis and cataract extraction were next in importance. Twenty-seven cases occurred after operation.

POST-TRAUMATIC GLAUCOMA

The cases of secondary glaucoma due to injury form a group too varied to be tabulated according to treatment. Many patients were seen some time after the injury in the stage of absolute glaucoma, when the only indication was for evisceration. In 1 case in which the tension was above 70 and there was large hemorrhage in the anterior chamber, irrigation of the chamber through a keratome incision and the use of a 50 per cent solution of sorbitol intravenously reduced the tension to normal and resulted in a useful eye. For a boy of 12 with secondary glaucoma due to a swollen traumatic cataract, the use of a solution of acacia intravenously and miotics reduced the tension for several days, after which the cortex was expressed with a good result. The case of

From the Department of Ophthalmology, Northwestern Medical School.

Read before the Section on Ophthalmology at the Ninetieth Annual Session of the American Medical Association, St. Louis, May 17, 1939.

1. Lehrfeld, L., and Reber, J.: Glaucoma at Wills Hospital, 1926-1935, Arch. Ophth. **18**:712 (Nov.) 1937.

Mr. B., aged 35, illustrates a type of glaucoma which follows contusion with little or no demonstrable damage to the eye. In this case there was no visible blood in the eye and only a moderate cellular reaction in the anterior chamber on slit lamp examination. Tension was 40. It was reduced by miotics and has never since risen above normal.

Tillema [2] has furnished a complete report on post-traumatic glaucoma, reviewing 106 cases, including 7 of his own. The outcome depends, as he pointed out, in most cases on the extent of the injury. He expressed the belief that in many cases glaucoma can be prevented by avoiding the use of atropine. When glaucoma does occur, the use of miotics is sometimes successful, while in others paracentesis or iridectomy is necessary. I can only agree with these opinions and add that the most important measure of all is to be on the constant watch for glaucoma after injury, so that appropriate measures may be taken early. When

TABLE 1.—*Causes of Secondary Glaucoma Found in a Series of Seventy Cases*

Cause	Number of Cases
Injury	20
Uveitis	14
Cataract extraction	19
Discission	6
Thrombosis of central vein	5
Subluxation of the lens	2
Cycloplegia	1
Serpent ulcer	1
Radium therapy	1
Rosacea keratitis	1
	70

the pupil dilates easily with homatropine and only a small amount of blood is present in the chamber, atropine is often unnecessary, and whenever it is used the tension must be watched carefully. It is usually safer to apply the tonometer than to record the tactile tension in such cases, and this is certainly the only way by which glaucoma can be detected in an early stage in many cases. There is no risk involved in the proper application of the tonometer unless an open wound is present.

LESS COMMON TYPES OF GLAUCOMA

The cases of glaucoma following thrombosis of the central vein need not be discussed under the heading of therapy, since neither surgical nor nonsurgical treatment is usually of any value when the condition is established. The outcome has been uniformly poor in this small group of cases. In 1 of these cases, that of a patient with diabetes, the use of a 50 per cent solution of sorbitol intravenously lowered the tension from 65 or above to below 20 on several occasions. Trephining was performed during one of these favorable periods, and tension could be kept below

2. Tillema, A.: Traumatic Glaucoma: Anatomic and Clinical Study, Arch. Ophth. **17**:586 (April) 1937.

35 after this by the use of miotics, with vision limited to the counting of fingers at the last test.

Of the less common types of glaucoma, only a few cases call for discussion. Postcycloplegic glaucoma (1 case) occurred in one eye of a woman of 21 after the use of atropine elsewhere for refraction. The condition behaved in every way like subacute primary glaucoma of the shallow anterior chamber type, being controlled for a year by the use of miotics with occasional mild attacks, during which tension rose to 35 or 40. Peripheral iridectomy resulted in tension of 12.5 to 15 mm. (Schiötz) without miotics. Vision remained 20/15. The glaucoma in the case listed as due to rosacea keratitis may also have resulted from the use of atropine. The acute attack failed to subside with the use of miotics but subsided after paracentesis followed by the use of miotics. No rise of tension has since occurred.

Glaucoma due to radium therapy is, fortunately, unique in my experience. In the case listed intensive treatment for an osteosarcoma of the frontal bone had caused many telangiectases of the skin and bulbar conjunctiva. Tension rose some time after treatment was completed and had been high for several weeks when I saw the patient. It did not respond to miotics, and every operation was followed by intraocular hemorrhage with return of tension. Tension was finally brought to normal, but the visual result was poor.

GLAUCOMA SECONDARY TO UVEITIS

Table 2 includes only the cases of glaucoma secondary to uveitis in which some treatment was carried out, and in cases 4 and 6 the glaucoma had reached the absolute stage. When a rise of tension occurred during an acute attack of iritis, the results of treatment were usually good. The therapy consisted of treatment of the iritis with the cautious use of mioties when the tension rose so high as to be considered dangerous. As soon as the tension was controlled, mydriatics were begun again, and in only 1 case (case 2) did a few synechiae result from the miotics. Epinephrine or its substitutes were not employed in the treatment of acute glaucoma, since previous experience had shown it to be exceedingly dangerous and likely to provoke a further rise of tension. In cases in which the tension was not controlled by miotics or in which the effect of miotics was undesirable because of the presence of plastic exudate, hypertonic solutions by vein were exceedingly useful and in some cases obviated the need of paracentesis. In cases in the early stage 100 cc. of a 50 per cent solution of dextrose was given, while in those observed more recently the same amount of a 50 per cent solution of sorbitol was preferred as having a more prolonged effect (according to Bellows and his associates [3]) and because it could be employed in persons with

3. Bellows, J.; Puntenney, I., and Cowen, J.: Use of Sorbitol in Glaucoma, Arch. Ophth. **20**:1036 (Dec.) 1938.

diabetes. In a few cases falling in other groups, a solution of acacia was employed, for reasons which will be discussed by Bellows in a later paper. The use of these hypertonic solutions was usually effective in bringing tension to normal. The procedure presents no danger if sorbitol is used, and although a few patients show little or no effect

TABLE 2.—*Data on Cases of Glaucoma Secondary to Uveitis*

Case No.; Age; Eye Affected	Type and Stage of Uveitis and Glaucoma	Nonsurgical Treatment	Surgical Treatment	Result
1, 32 left eye	Seen in an acute attack of glaucoma after recurrent iritis; tension, 47.5	Miotics, without effect	Iridectomy	Tension, 10.5; vision, 20/20; no recurrence known
2, 39 left eye	Seen during an acute attack of iritis while the eye was under the influence of atropine; tension increased to 41	Miotics; intravenous injections of 50 per cent solution of dextrose; typhoid vaccine; later atropine; treatment of infected sinuses	.....	Tension reduced to normal; vision returned to 20/15; later had iritis in right eye without glaucoma
3, 45 both eyes	Seen after severe recurrent acute iritis; eyes quiet; tension, 40 in right eye and 52 in left eye; vision, perception of light in right eye and 20/25 in left eye	Miotics and epinephrine pack; tension reduced before operation	Sclerectoiridectomy of left eye; epinephrine	Tension, 40 in right eye and 27 in left eye; vision, perception of light in right eye and 20/50 in left eye
4, 44 right eye	Seen long after chronic iritis; eye quiet; iris bombée; perception of light; poor projection; tension, 45	.....	Double iris puncture	Vision, perception of light; tension, 44; no pain
5, 42 right eye	Seen long after chronic uveitis; pupil secluded; previous bilateral iridectomy; tension, 35-50; vision, 2/200	Epinephrine	Iridectomy	Vision, 5/200; tension, 25.5
6, 75 left eye	Seen with sympathetic ophthalmia; right eye had been removed; vision, perception of light; tension, 80; anterior chamber very shallow; pupil occluded	.....	Iridectomy and extraction of opaque lens; iridotomy; cyclodialysis	Tension normal for several months but rose almost to former level
7, 70 left eye	Seen in the third week of acute iritis; tension, 47.5	Epinephrine; typhoid vaccine; intravenous injection of dextrose	Paracentesis; iridectomy; paracentesis	Tension, 18; vision, perception of shadows, due to senile cataract

from it, only six to eight hours are wasted in such an attempt. It is exceedingly convenient to have such a measure at one's disposal, as paracentesis on an inflamed eye is by no means a pleasant procedure.

Clarke [4] recently reported a most interesting series of 200 cases of glaucoma in which acetylbetamethylcholine chloride (mecholyl), a derivative of choline, with or without prostigmine, was employed. Both drugs are powerful parasympathetic stimulators, and prostigmine acts probably

4. Clarke, S. T.: Am. J. Ophth. **22**:249,1939.

by neutralizing the esterase produced in the tissues which normally inhibits the action of choline almost immediately. The combination of a 20 per cent solution of mecholyl with a 5 per cent solution of prostigmine used as drops brought tension to normal in many cases in which the use of other miotics and epinephrine had failed. In some cases 20 mg. of mecholyl alone was injected retrobulbarly with marked lowering of tension but with occasional undesirable systemic effects, requiring the use of atropine by vein or subcutaneously. In the series were approximately 50 cases in which the glaucoma was secondary to uveitis, cataract extraction and other conditions.

Since Clarke's report and a personal communication from him, I have been trying mecholyl and prostigmine in suitable cases.[5] In 2 cases of acute secondary glaucoma in which the tension was not controlled by miotics it was reduced to normal after retrobulbar injections of 20 mg. of mecholyl, and 1 of these was a case in which the use of a hypertonic solution intravenously had failed. Instillation of a 20 per cent solution of mecholyl and a 5 per cent solution of prostigmine produced marked miosis in other cases, but its effect on tension has not yet proved to be definitely superior to that of the stronger miotics, in my limited experience. Instillation of this has failed to control tension in a few cases of acute glaucoma.

GLAUCOMA FOLLOWING CATARACT EXTRACTION

Glaucoma following cataract extraction (table 3) is represented by 11 cases, in 6 of which operation was performed elsewhere. The one fact which stands out is that in all cases the glaucoma occurred after extracapsular extraction, while in none of them was it seen by me after intracapsular extraction. This was also true in the large series of cases reported by Fox.[6] His 14 cases in 1,182 extractions performed at the Bellevue Hospital represents an incidence of 1.2 per cent, and in all of them the glaucoma followed extracapsular extraction. In his review of the literature to 1936 he cited Fage and Wolfe, who were sure that intracapsular extraction is a most important factor in the prevention of secondary glaucoma. Davis[7] saw no cases in his series of 200 intracapsular extractions, but Arnold Knapp[8] saw 4 after 500 extractions in the capsule, and in 4 cases with preexisting glaucoma, glaucoma recurred after extraction.

---

5. These cases are not included in the tables.

6. Fox, S. A.: Postoperative Glaucoma, Arch. Ophth. **16**:585 (Oct.) 1936.

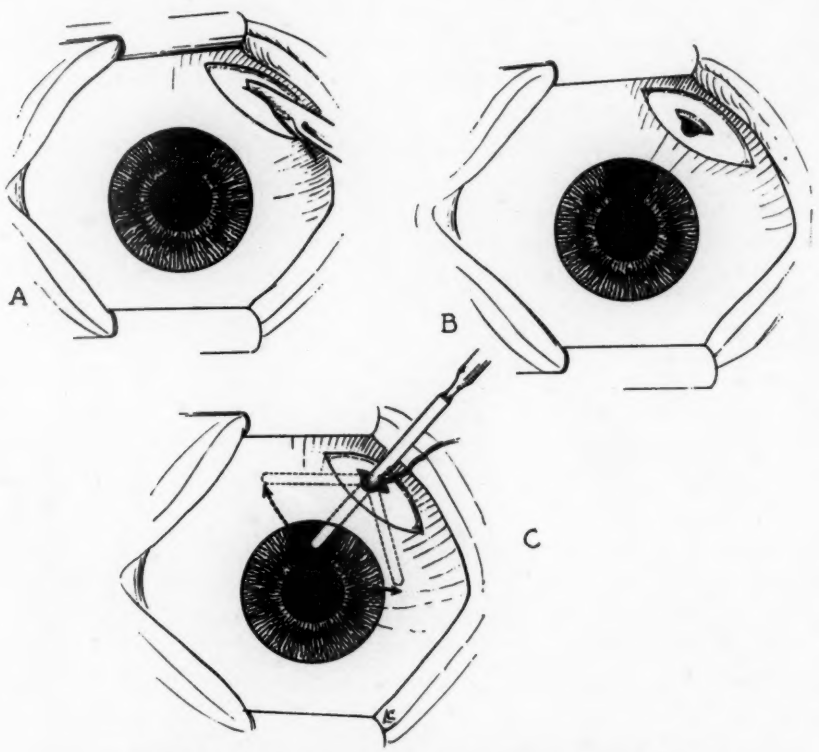
7. Davis, F. A.: Personal Experiences with Intracapsular Cataract Extractions, Arch. Ophth. **19**:867 (June) 1938.

8. Knapp, A.: Complications of Forceps Intracapsular Operation for Cataract Based on Analysis of Five Hundred Successive Cases, Arch. Ophth. **16**:770 (Nov.) 1936.

TABLE 3.—*Data on Cases of Glaucoma Following Cataract Extraction*

Case No.; Age; Eye Affected	Time After Operation Type of Operation	Details of Operation	Nonsurgical Treatment	Surgical Treatment	Result
1, 69 right eye	3 mo. Combined extracapsular extraction	Operation elsewhere; cortex remaining; tension, 51.5; vision, perception of light (uncorrected)	Physostigmine; dextrose intravenously	Cyclodialysis; 2 years later discission	Tension normal with physostigmine; acute rise of tension after discission controlled by dextrose and physostigmine; tension, 22; vision, 20/30 with correction
2, 61 right eye	1 mo. Combined extracapsular extraction	A good deal of cortex left; some iritis; tension, 51.5	Epinephrine; pilocarpine baths; dextrose intravenously	Paracentesis; cyclodialysis repeated 7 mo. later	First cyclodialysis reduced tension for several months; second produced hypotony; tension, 7 to 10; vision, 20/30 with correction
3, 73	8 mo. Combined extracapsular extraction	Operation elsewhere; absolute glaucoma; trephining had been performed without success; tension, 77; vision, no perception of light	.....	Diathermy; coagulation of vitreous; no effect; enucleation	Enucleation
4, 55 left eye	2 yr. Combined extracapsular extraction	Some cortex and iridocyclitis; adhesion of one pillar to scar; tension, 41 to 45	Physostigmine and epinephrine	Cyclodialysis	Tension, 31 with physostigmine; vision, 20/15 with correction
5, 72 left eye	1 mo. Combined extracapsular extraction	Operation elsewhere; seen 3 mo. later; tension, 44	Miotics; epinephrine pack	Cyclodialysis	Tension remained normal with pilocarpine; vision, 20/30 with correction
6, 64 left eye	2 mo. Combined extracapsular extraction	Some cortex left; recurrent erosion of cornea; tension, 47.5	Miotics; epinephrine	Needling and division of cortex pillar; cyclodialysis; blepharoplasty	Tension normal after cyclodialysis (27.5); vision, 6/200; old fundus lesion due to myopia
7, 55 left eye	8 mo. Combined extracapsular extraction	Operation elsewhere; pupil drawn up; cyst of anterior chamber developed; tension, 44	Miotics; radium for cyst	Cyclodialysis; iridectomy and partial excision of cyst	Tension, 44; vision, 2/200; cyst recurred
8, 27 right eye	Probably developed soon after operation in infancy	Nine operations elsewhere; tension, 71; vision, 1/100	Miotics	Cyclodialysis repeated	Tension remained 5 after second operation; vision, 1/100 field very small
9, 47 left eye	2 mo. Extracapsular extraction and peripheral iridectomy	Retained cortex and iritis; tension, 38 to 35	Miotics; epinephrine	.....	Tension, 11; vision, 20/15
10, 50 right eye	3 mo. Combined extracapsular extraction	Operation elsewhere; prolapse of iris; pillar adherent to scar; tension, 47.5 to 44	Miotics	Cyclodialysis	Tension, 25.5; vision, 20/25—2
11, 37 right eye	5 wk. Combined extracapsular extraction	Very little cortex; was on atropine; tension, 38 to 32	Miotics; ergotamine	Later needling	Tension, 12.5; vision, 20/15

In Fox's series of 31 cases following both extraction and discission, only 10 of the patients were dismissed with vision of 16/200 or better, while only 8 had normal tension. These results may be explained in part by delay of clinical patients in reporting for examination, many being already in a late stage before treatment was begun. In my series 7 patients obtained vision of 20/30 or better, 3 having vision of 20/15, while 8 had normal tension. In case 4, in which the tension varied between 27.5 and 32 with physostigmine, vision was 20/15 five years after operation. In case 3, in which the glaucoma was in the absolute



Modified technic of cyclodialysis for secondary glaucoma

stage enucleation was required. In the other example of uncontrolled tension (case 7) a cyst of the anterior chamber developed which recurred after removal and was not controlled by radium therapy. The patient was not seen until eight months after extraction elsewhere. He had a prolapsed iris. In all but 1 of my cases a considerable amount of cortex was left at operation, and definite iridocyclitis occurred, probably as a result of this. In some cases one or both pillars of the iris were adherent to the deep wound. It would seem that next to intracapsular extraction removal of all possible cortex by irrigation and careful replacement of the iris and capsular tags are the most important measures in preventing glaucoma.

In treatment unquestionably the most important measure is early recognition of the condition. Repeated use of the tonometer postoperatively should certainly be a routine procedure in any cases in which there is postoperative iritis and probably in all cases. It is always surprising to note the effect of miotics in cases in which complete iridectomy is done. Glaucoma usually comes on when the iritis has become almost or completely quiescent. In this stage miotics are not contraindicated, and in cases in which the glaucoma is recognized early, they may be effective. The too prolonged use of atropine after it is no longer necessary is undoubtedly responsible for glaucoma in some cases. Although, as previously stated, epinephrine is, in my experience, dangerous in forms of glaucoma accompanied by inflammation, in that following cataract extraction it has often proved useful. It was seldom employed unless the iritis was quiescent, and in several cases it brought tension to normal for varying periods. In cases 9 and 11 epinephrine and physostigmine controlled tension through a critical period, and it later remained normal without miotics and without resort to operation. In 1 case (case 2) epinephrine produced an acute exacerbation of the condition necessitating paracentesis and later cyclodialysis. The administration of dextrose intravenously was of value in 2 cases in preparing for operation.

When glaucoma was well established, as it was in all the other cases, operation was necessary, and this is to be expected from the mechanical nature of the obstruction assumed to be present in these cases. When other measures fail to control tension, a prompt resort to operative measures is as important as in any other form of glaucoma, and delay in reaching such a decision, either by the surgeon or by the patient, has undoubtedly been responsible for an unfortunate outcome in many cases.

Cyclodialysis was the operation chosen in 8 cases. It was chosen first because of a number of discouraging results following other operations, including corneoscleral trephining and iridencleisis, in this special type of glaucoma. Later its special advantages in this condition were recognized, and it was found that Elschnig and his school, represented in this country by Gradle, had for years advocated it as the operation of choice in glaucoma following cataract extraction or discission. The same opinion was recently expressed by St. Martin.[9] Its special advantages are as follows:

1. It is the only operation which may be performed following cataract operation without presentation of vitreous. This is apparently what often prevents success of the filtering operations in this condition.

2. By it the adherent pillars of iris and tags of capsule may be separated from the scar by the spatula. The supposed cause of ocular hypertension is thus directly attacked.

---

9. de Saint-Martin: Bull. et mém. Soc. franç. d'opht. **49**:157, 1936.

3. When iridectomy has been performed, by directing the spatula especially to the area of the coloboma, the new channel for drainage is especially likely to remain open. The condition brought about is that achieved by Wheeler's combination of iridectomy and cyclodialysis.[10] Barkan and his associates [11] and Vannas [12] have shown that cyclodialysis is successful only when the iris does not readhere to the sclera, closing the new opening. Here the area of the coloboma is free of iris.

4. It may be repeated in other quadrants if necessary.

The technic employed varies in a few details from the classic procedure of Heine. When tension is above 35 preliminary reduction by intravenous injection of sorbitol is routinely employed. One hundred cubic centimeters of a 50 per cent solution is given by vein the evening before operation. Retrobulbar injection is also important, as cyclodialysis is otherwise likely to be an exceedingly painful procedure. Fixation is made with H. Gifford's fixation forceps on the tendon of the superior rectus muscle and is maintained until the close of the operation. The incision begins 7.5 mm. behind the limbus in the area between either horizontal and the superior rectus muscles. If either pillar is seen to be more adherent to the wound, the corresponding side is chosen; otherwise the temporal side is preferred as being more accessible. Gonioscopy will in the future be a definite aid in choosing the best site for operation. The incision is made with a rounded sharp Bard-Parker knife and is beveled at an angle of approximately 45 degrees. Since beveling the incision in this way I have not met with the accident of perforating the ciliary body and losing vitreous which had occurred when the incision was made directly through the sclera. A fine suture on a Kalt needle is sometimes placed through the scleral tongue so as to raise it up and observe the first complete perforation of the sclera. The incision must extend through the sclera throughout a length of 3 to 4 mm. so as to allow free play to the spatula. When the incision is complete, the Holth punch is introduced gently beneath the tongue of sclera, and a semioval button of approximately 3 mm. is excised. This embodies the idea of Sallman, who employed trephining for the purpose of allowing greater freedom to the spatula. Whether the free drainage through such an opening serves any useful purpose is somewhat doubtful, as no bleb is formed and the scleral opening seems to heal completely. A narrow, thin spatula is introduced, hugging the sclera, and is directed into the area of the coloboma, which is completely free from the sclera. Both pillars and an area of iris root, making a total extent of approximately one-fourth

10. Wheeler, J. M.: Iridectomy with Cyclodialysis for Reduction of Ocular Tension, Arch. Ophth. **16**:569 (Oct.) 1936.

11. Barkan, O.; Boyle, S. F., and Maisler, S.: Am. J. Ophth. **19**:21, 1936.

12. Vannas, M.: Klin. Monatsbl. f. Augenh. **95**:629, 1935.

the corneal circumference, are usually freed. The sclera for several millimeters around the incision is also undermined. A running untied suture closes the conjunctival incision.

Contrary to the custom of some operators, such as Gradle, I usually employ a 0.5 per cent solution of physostigmine at the close of cyclodialysis and for some time afterward. It appears reasonable to expect that miosis will tend to prevent adhesions of the iris root to the sclera, and I feel that this is important enough to outweigh its disadvantages, except in cases in which a considerable hemorrhage is present in the anterior chamber. Here homatropine or neosynephrin may be employed to prevent seclusion of the pupil, but I believe that either drug should be replaced by miotics as soon as the blood is absorbed or has settled away from the pupil. When acute hypotony occurs, the use of miotics will of course be discontinued.

As will be seen from table 3, the operation was successful in reducing tension in all but 2 of the 8 cases. In case 2 it was necessary to repeat it in the opposite quadrant. In case 7 it was unsuccessful on account of epithelial lining of the anterior chamber. In case 4 tension was reduced to normal for several years, and at the time of writing it varies from 27.5 to 32 with the use of miotics, while vision is 20/15 and the field good.

No complications occurred in this series except a rather alarming hypotony in cases 2 and 4, with some rather troublesome opacities in the vitreous in case 2. Hyphema occurred in a number of cases but cleared up uneventfully, the patient being elevated in bed after the operation. Only three cyclodialyses were performed in Fox's series, and only one was successful. He preferred corneoscleral trephining, and in spite of the drawbacks mentioned it was often successful in its effect on tension, though visual results were not good. I feel like emphasizing the results obtained by cyclodialysis in this series because of a rather widespread pessimism as to the results of operation in such cases, which may in some instances deter the ophthalmologist from any attempt at surgical intervention when it is urgently indicated. Every ophthalmic surgeon should be familiar with the technic of cyclodialysis, even though he may feel, as I do, that it is not the operation of choice in cases of chronic simple glaucoma.

GLAUCOMA FOLLOWING DISCISSION

Glaucoma following discission (table 4) is represented by 6 cases, and I have preferred to separate these from the previous group because they present a somewhat different problem. There were 10 cases in Fox's series following 447 discissions, an incidence of 2.2 per cent, or twice that following cataract extraction. The greater likelihood of glaucoma after discission than after extraction is borne out by the figures

of others quoted in his review. P. Knapp[13] saw 3 cases of severe glaucoma following 88 discissions, while he found a transitory rise of tension much more commonly. The tension in these cases was usually controlled by miotics, but in the 3 cases of a serious nature the visual result was bad, while tension remained high in 2. Knapp is an advocate of early discission, while the membrane is still soft, and employs a miotic postoperatively. I can subscribe to the use of miotics postoperatively and would add a warning against preliminary use of atropine. Homatropine is sufficient, if any preliminary mydriatic is employed.

TABLE 4.—*Data on Cases of Glaucoma Following Discission*

Case No.; Age; Eye Affected	Time After Operation Type of Operation	Details of Operation	Nonsurgical Treatment	Surgical Treatment	Result
1, 55 right eye	Day after operation	Tension, 44; controlled by physostigmine; recurred	Miotics; epinephrine packs	Paracentesis with incision of iris root; cyclodialysis	Tension very low (5); vitreous not clear; vision, 20/25
2, 28	2 days after preliminary discission	Rapid swelling of lens; tension, 45 to 50	Physostigmine	Corneal expression of swollen cortex	Normal course; vision, 20/15
3, 62 left eye	Day of operation	Membrane was tough; tension over 80	Pilocarpine bath; dextrose intravenously	.....	Tension, 17; vision, 20/25
4, 40 left eye	Few days	Complicated cataract; simple expression; small covered prolapse; cyclitis; tension, 35-45	Miotics; epinephrine	Cyclodialysis	Slow recovery from cyclitis; tension, 20 with physostigmine; vision, 20/30—3
5, 65 right eye	Two days	Tough band of membrane cut with some traction; closure of central artery; tension, 59.5	Miotics; epinephrine	Cyclodialysis 2 days after attack	Tension below 5; perception of light; faulty projection
6, 32 right eye	Two weeks	No apparent cause; normal course following corneal expression of lamellar cataract; tension, 41	Miotics	.....	Tension, 20-15; vision, 20/15

In spite of these precautions, secondary glaucoma will occur in an occasional case. In some cases it is a traumatic reaction to pulling on a tough band of membrane. The remedy for this is, of course, a sharp discission knife, employed to cut and not to tear the membrane. Wheeler's method of discission and his knife are exceedingly valuable when the membrane is old and tough. It is usually unnecessary to cut the peripheral bands of membrane which are likely to be toughest, since a central opening of 3 to 4 mm. is sufficient. The tragic result of attempting to do too much is illustrated by case 5. After the thin central membrane was divided, an attempt was made to cut a tough

13. Knapp, P.: Klin. Monatsbl. f. Augenh. **99**:15, 1937

peripheral band, with some traction. This was followed by severe glaucoma, and in spite of prompt operation with reduction of tension the attack was apparently responsible for complete closure of the central retinal artery, reducing vision from 20/40 to perception of light.

A second type of glaucoma is apparently due to prolapse of the vitreous into the anterior chamber, with obstruction of the iridocorneal angle. It occurs in cases in which there are a thin membrane, which is easily divided, and a wide pupil, which probably results in a rather large opening in the membrane. It seems safest to avoid making the central opening unduly large, and the use of a miotic is especially useful in such cases, since it limits the size of the prolapse of the vitreous, if the vitreous is normal.

In most of the cases in this series the glaucoma was discovered promptly, and it responded to the use of miotics, epinephrine and intravenous injections of dextrose. In case 4 an old cyclitis, which preceded the cataract, was stirred up, and cyclodialysis was necessary. Tension was controlled with difficulty after operation but finally subsided. The unfortunate result in case 5 has been described, the visual result being nil, although tension was brought below normal.

CONCLUSIONS

1. The treatment of secondary glaucoma, even more than that of primary glaucoma, is a matter of individualization. Judgment and experience are required as in few other conditions, together with versatility and the courage to follow out clinical indications without loss of time.

2. Most important is early recognition of the condition, in which nothing is more essential than use of the tonometer in every case in which the possibility of glaucoma exists.

3. Miotics are useful, and it would seem that mecholyl may prove a valuable recent addition to this category.

4. Epinephrine and its derivatives, though dangerous during active iridocyclitis, are often of value in glaucoma following cataract extraction or discission.

5. Intravenous injection of hypertonic solutions is exceedingly useful, may succeed in aborting an acute attack and will usually allow operation under relatively favorable conditions. It will obviate resort to paracentesis in many cases.

6. Operative intervention is often necessary and should be promptly employed when tension cannot be controlled by other means. The operations which proved of most value in this series were iridectomy for glaucoma following uveitis and cyclodialysis for glaucoma following cataract extraction or discission.

ABSTRACT OF DISCUSSION

DR. EDWARD C. ELLETT, Memphis, Tenn.: I have had too little experience with the newer miotics referred to, viz., mecholyl and prostigmine, and my experience with the hypertonic solution intravenously has been disappointing. In general, the secondary glaucomas have not yielded to miotics, and when relief has been obtained it usually has been through operation.

Contusions of the eye, with hemorrhage in the vitreous, seem to account for much more secondary glaucoma than when the hemorrhage is limited to the anterior chamber. The glaucoma which follows obstruction of the central retinal vein is my conception of what can be properly termed hemorrhagic glaucoma. Years ago (1893) Bourgon described this condition as showing two distinct stages: (1) hemorrhagic period and (2) a period of confirmed glaucoma. My experience leads me to prefer enucleation if any operation seems to be necessary. Obstruction of a branch, even large branches, does not seem so likely to cause glaucoma.

Postcycloplegic glaucoma is fortunately rare. It is hardly correct to say that the cycloplegic causes the glaucoma. Rather it precipitates an attack in an eye already subject to glaucoma or strongly predisposed to it.

Secondary glaucoma accompanying uveitis is always a source of great anxiety. In general, it is a good plan to treat the uveitis without special reference to the hypertension, that is, with atropine. I have not hesitated to use the strong epinephrine preparations and can record some gratifying results and some failures, but no disasters. Operation is likely to be disappointing, and my own feeling is that repeated paracentesis should be given a fair trial before any more formidable operation is tried.

Glaucoma following cataract extraction or discission of a secondary cataract is especially distressing because it follows a surgical procedure and the operator must feel the responsibility. Medical means failing, I feel, as Dr. Gifford does, that these cases present the most definite indication for cyclodialysis, and in them cyclodialysis gives its best results.

With regard to the type of cataract operation most likely to be followed by glaucoma, my experience does not justify generalization, but I have seen it after both intracapsular and extracapsular extractions; I have observed it more often after the latter type of operation and more often still after discission of a secondary cataract, and especially when the operation entailed traction on a resistant membrane. In these cases if miotics fail to relieve the tension my choice of operation would be cyclodialysis.

DR. THEODORE L. TERRY, Boston: Having seen some of the results of the two synergistic miotics, mecholyl and prostigmine, reported by Dr. Clark, and having observed favorable results in a few of my own patients with glaucoma for whom Dr. Clark was able to reduce the tension to normal after other miotics had failed, I am highly impressed with the value of these two drugs. In the group of cases I mentioned there are several instances of secondary glaucoma. In 1 instance of bilateral congenital glaucoma favorable results were obtained for a time in one eye.

These drugs are tolerated much better than physostigmine. Mecholyl and prostigmine have proved of value also in lowering the tension preliminary to operation. The use of a 20 per cent solution of mecholyl and a 5 per cent solution of prostigmine as a collyrium at ten minute intervals for one to two hours often is efficacious. If necessary, greater effect can be obtained by injecting 25 mg. of mecholyl retro-orbitally. (The drug must not be given internally to asthmatic patients.) The articles by Myerson and Thau (ARCH. OPHTH. 18: 78 [July] 1937) and Clark (*Am. J. Ophth.* 22: 249, 1939) give the rationale of this therapy.

Microscopic sections made from an eye on which cyclodialysis had been done revealed the following changes (a lantern slide was shown): The ciliary body and the anterior portion of the choroid were separated, and the scleral spur was torn from its attachment. This separation of the ciliary body permitted relaxation of the zonule, resulting in partial posterior dislocation of the lens and tilting backward in the portion near the region of the operation. Disinsertion of the retina, no doubt a rare complication of the operation, was present. The fact that this is the only pathologic specimen that I have found at the pathology laboratory of the Massachusetts Eye and Ear Infirmary with changes due to cyclodialysis speaks well for the operation.

DR. CLIFFORD WALKER, Los Angeles: I wish to emphasize strongly the value of the use of short wave treatment in the early stages of the combination of iritis and glaucoma. The action has been extremely successful in all of the cases I have had and seems to produce dilatation of the venous capillaries, as judged by the increased carbonates they carry, and also of the lymphatic capillaries, even Schlemm's canal, as well as of the arteriole capillaries, which bring in more nutrition and drain more waste.

The slit lamp will plainly show the removal of debris that may appear in the anterior chamber. In the early stages, then, before severe complications have intervened, the glaucoma in many of these cases would be held in check and the use of atropine and pilocarpine may be reduced considerably and at times stopped since the drainage is accomplished by the short wave treatment remarkably well.

DR. SANFORD R. GIFFORD, Chicago: I should like to mention the treatment of glaucoma following discission. Glaucoma can be prevented in many cases by avoiding the use of atropine definitely. I believe that atropine should never be used after discission. If I have to dilate the pupil before the discission I use nothing but homatropine, and I never use atropine afterward. In fact, in some cases in which a wide opening has been made in the membrane and there is a good deal of vitreous in the anterior chamber, I believe that it is good practice to use 1 drop of physostigmine at the close of the operation, and to watch the patient carefully the next day, because the complication of secondary glaucoma is almost the only severe complication that one usually sees after discission. It is twice as common as it is after cataract extraction.

There is another thing I believe one should not do in performing discission and that is one should not make traction on tough bands of membrane. An unfortunate result is reported in my paper in which, after getting a good opening in the central thin part of the membrane,

I attempted to cut a peripheral band and used traction which was unnecessary, causing an unfortunate outcome. One must, of course, have a sharp knife and cut instead of tearing.

I should like to emphasize once more the suitability of cyclodialysis for glaucoma following cataract extraction and discission, since with this method one is able to attack the adhesions and separate them definitely. In cases in which iridectomy has already been done there is the advantage that Dr. Wheeler pointed out in a combination of iridectomy and cyclodialysis. Then again I want to say that this is the only operation in which loss of vitreous does not occur or in which there is no danger of vitreous presenting after a cataract extraction has been done.

TANGENT SCREEN SCOTOMETRY

VALUE IN DIAGNOSIS, PROGNOSIS AND EVALUATION OF THERAPY

WALTER F. DUGGAN, M.D.
UTICA, N. Y.

The tangent screen and the ophthalmoscope are the two instruments essential for the accurate diagnosis of visual disturbances which cannot be attributed to refractive errors or to changes in the transparency of the refractive media of the eye. Moreover, in cases in which the ophthalmoscopic findings are essentially negative, the tangent screen is indispensable. With the ophthalmoscope it is possible to detect altered anatomic structure (pathologic change) in the fundus. With the tangent screen and the perimeter it is possible to test altered function of the visual sensory system from the rods and cones to the calcarine fissures. The function may be depressed by causes inside or outside of this system. If one considers the variable factors of size and color of test objects, the distance at which the screen is placed, the illumination, the size and position of defects, the slope of the defects, whether there is proportion or disproportion, whether the field changes are unilateral or bilateral and whether the defects are congruous or incongruous (when both eyes are involved), one can usually locate the level of the lesion, sometimes determine whether it is inside or outside the optic pathways and occasionally make a prognosis.

Just as symptoms may be present without visible signs of disease, so can careful scotometric examination indicate alterations in function before there are obvious changes in anatomic structure. When there is visible pathologic change, scotometric examination may show that the loss of function is more extensive and the lesion more advanced than the ophthalmoscopic picture seems to indicate. Just as photography of the fundus gives a picture of altered anatomic structure, so does scotometric examination give a picture of altered function.

While the idea of three-dimensional perimetry and scotometry originated with Bjerrum and Roenne, most of the English-speaking ophthalmologists owe their knowledge of the subject to Traquair's monograph.[1] The fields to be discussed later were taken according to the principles elucidated by Traquair.

1. Traquair, H. M.: An Introduction to Clinical Perimetry, ed. 3, St. Louis, C. V. Mosby Company, 1938.

The otologist plotting an audiogram has much in common with the ophthalmologist who uses three-dimensional perimetry, except that the otologist can express the loss of hearing for the various wavelengths as a percentage deviation from the normal, an ideal as yet unattained by the ophthalmologist in mapping out areas of depressed visual function. The old crude tests of hearing by whisper, watch and spoken voice, by determination of the upper and lower limits of hearing and by the time relations between bone-conduction and air-conduction time are roughly analogous to the time-honored methods of field testing by confrontation, by perimetric examination with ½ and 1 degree test objects and by determining the limits of the color fields.

I do not advocate abolition of the old crude tests. One must adjust one's method to each particular case. In some cases of hemianopia, retinal detachment, retinitis pigmentosa, glaucoma and atrophy of the optic nerve, even confrontation tells one all one needs to know. However, in the early phases of many diseases in which function is only slightly depressed, a refined technic is essential for diagnosis, prognosis and the evaluation of therapy.

In my opinion, in disease the first changes are physiologic, i. e., due to some interference with the oxygenation and nutrition of nerve cells or nerve fibers. By the time there are visible anatomic changes in the choroid, retina or nerve fibers, with gross changes in function, a lesion is relatively far advanced. If one can diagnose and treat a lesion while it is still producing physiologic change, better therapeutic results can be expected than if one waits until it produces anatomic change, at which time altered physiologic function is fixed more or less permanently by altered anatomic structure.

In a lesion of the visual sensory system, function may be completely abolished at the center of the lesion, but as one passes toward the periphery of the lesion function will be progressively less depressed, until at the edge of the lesion sensitive tests may be necessary to determine the boundary between normally and subnormally functioning tissue. The sensitivity of the stimulus used should vary inversely with the degree of depressed function one wishes to demonstrate. Test objects subtending large visual angles can be used to map areas of absent or greatly depressed function, but test objects subtending tiny visual angles (and, therefore, very sensitive) must be used to define areas of slightly depressed function.

Therefore, to define the characteristics of any lesion and the field defect resulting, at least two white test objects, one of which should be extremely small, are necessary. By this procedure one can locate the scotoma and define its shape, extent and slope.

Furthermore, in the case of all active lesions, in addition to the defect for the smallest white object used there is always a larger defect for a colored test object. This color defect is disproportionately large in all active and rapidly developing lesions. In slowly developing lesions the factor of disproportion is usually less marked.

The defect for colors is the first to appear and the last to disappear with any lesion affecting the visual system. It may be stated axiomatically that if there is a field defect for white there is also one for color. The reverse is not necessarily true. I agree with Thomasson [2] and Magitot and Dubois-Poulsen [3] that colored test objects are important chiefly as an aid to differential diagnosis. The reasons for this may be summed up as follows: 1. Color defects cannot be mapped as precisely as defects in the white field. 2. The patient is asked to determine when the sensation changes from a hue (unsaturated color) to the primary color rather than to determine the boundary between a nonseeing and a seeing area, as is the case with white test objects. 3. Normal color fields are extremely variable. 4. A few patients will be red-green color blind. 5. The patient tends to name the primary color used as soon as he recognizes the unsaturated color. Colored test objects are valuable only if one recognizes their limitations.

If a lesion involving the neuroepithelium or the nerve fibers heals but leaves a permanent anatomic defect, a physiologic line of demarcation forms; all cells or fibers to the inner side of this line atrophy and all to the outer side regain normal or nearly normal function. Such a healed lesion will give a permanent field defect with a steep edge, the defect being approximately the same size for all test objects and little larger for colors. This type of field defect is best seen in cases of chronic glaucoma after successful operation.

The slope of a scotoma is seen best in processes involving the optic nerve (cases 9 to 14). Here the scotoma is small for a large test object and large for a small test object (white), while the defect for a red test object is even more extensive. To my mind, this can be explained only by assuming zones of decreasing anoxia around a spastic blood vessel, with the visual function being depressed in direct proportion to the tissue anoxia.

In cases of chorioretinal lesions it is usually more difficult to demonstrate nuclei. Even with acute lesions the slope of the scotoma is steep owing to the fact that edema of one region does not vitiate the nutrition of nearby regions. In cases of involvement of the optic nerve, on the

2. Thomasson, A. H.: Plea for Greater Uniformity in Methods of Field Taking, Arch. Ophth. **12**:21 (July) 1934.

3. Magitot, A., and Dubois-Poulsen, A.: Condamnation des index colorés en périmétrie clinique, Ann. d'ocul. **174**:649 (Oct.) 1937.

other hand, the thick inelastic sheath, acting like a tight bandage, allows a small zone of edema to increase the tissue pressure throughout the whole nerve, so that nearly all the nerve fibers may be unable to conduct visual impulses, although the primary lesion itself may be relatively small. This is well demonstrated in case 10.

The only way to learn is by practice. This is as true of scotometry as it is of any other diagnostic procedure in ophthalmology. The present popular habit of relegating examination of the visual fields to a technician is as illogical as having a technician report on the examination of the fundi. In many cases examination of the visual fields is the most important diagnostic procedure in the work-up of a case. As such, it deserves more time and more attention than it often receives.

SENSITIVITY OF TEST OBJECTS

Many articles on examination of the visual fields are concerned with minor details, such as whether 750, 1,000 or 2,000 mm. is the best distance for the tangent screen, whether a gray or a black background is preferable, whether the fixation point is black on white or white on black and whether the field should be marked off in concentric circles or squares. If one standardizes as many variables as possible, I think that the most important part of the examination is to have test objects subtending small visual angles.

Perimetric examination at 330 mm. with a ¼ or ½ degree test object is a crude clinical procedure. Even scotometric examination at 1,000 mm. with a 0.5 mm. or a 1 mm. test object is relatively crude. If one assumes that the sensitivity of two round test objects varies inversely as the square of their radiuses, it is obvious from table 1 (column 6) that in a radius of 8.3 degrees from the fixation point a 0.5 mm. white test object is only one fourth as sensitive as is theoretically necessary and a 1 mm. white test object is only one sixteenth as sensitive as is theoretically necessary. A 10 mm. object which is roughly equivalent to a 3 mm. object on the perimeter is only one sixteen-hundredth as sensitive in this zone as is theoretically essential. If for practical purposes one takes a 0.5/1,000 white stimulus as the smallest stimulus which is seen normally out to 24 degrees, this is more than three hundred times as sensitive as a 3/330 stimulus on the perimeter in the same region of the field. To obtain a similar degree of sensitivity with the perimeter at 330 mm., the test object would need to be 0.167 mm. in diameter, a practical impossibility at the present time. Moreover, since the sensitivity of field testing depends on using test objects subtending a small visual angle, it is obvious that the only way to increase the sensitivity of the perimetric test will be to increase the radius of the perimeter, since there is a practical limit to the size of test objects obtainable.

Moreover, it must be obvious that the tangent plate furnished with some perimeters, which is placed inside of the arc, so that the working distance is about 300 mm., is a tangent screen in name only. One is still working at a short distance, and the test objects are slightly less sensitive than when used on the perimeter. It is obvious from this that the 3/330 (or 10/1,000) stimulus is adequate for demonstrating advanced field defects; only the 0.5/1,000 or the 1.0/1,000 stimulus can be used for detecting the early lesions. From this short discussion it may be stated that if the perimetric test reveals a field defect within the 25 degree circle, it can also be demonstrated on the tangent screen; the reverse is not necessarily true. Moreover, with a peripheric contraction of the field which does not extend to within 25 degrees of the fixation point for

TABLE 1.—*Isopters for White (Traquair)*

Limit of Field		Size of Test Object, Mm.	Visual Angle	Reciprocal*	
Nasal	Temporal			Of Visual Angle	Of Area of Test Object
		Tangent Screen at 1,000 Mm.			
1.3°	1.3°	0.16	0.57′	120	14,400
8.3°	8.3°	0.25	0.86′	80	6,400
24°	26°	0.50	1.72′	40	1,600
26°	33°	1.00	3.44′	20	400
36°	48°	2.00	6.86′	10	100
60°	82°	5.00	17.2′	4	16
62°	93°	10.00	34.3′	2	4
62°	99°	20.00	1.14°	1	1
		Perimeter at 330 Mm.			
57°	80°	1.0	10.4′	6.6	43.6
60°	87°	2.0	20.8′	3.3	10.9
62°	90°+	3.0	31.2′	2.2	4.8
62°	90°+	5.0	52.0′	1.3	1.7

* Calculated from tangent screen values for perimeter.

a 3/330 stimulus, it can usually be demonstrated with a 1/1,000 stimulus (which is approximately ninety times as sensitive) that the defect may extend to within 5 or 10 degrees of the fixation point. This is particularly true in cases of retinitis pigmentosa.

In table 1 I have indicated the limits of the field for the various-sized test objects nasally and temporally from the fixation point for distances of 1,000 and 330 mm. For purposes of comparison, these figures are modified from Traquair's tables. It is true that the fields for a 1/1,000 and a 2/2,000 white stimulus are not identical, but the visual angles subtended by these two test objects are identical, so I have recalculated all his figures for a distance of 1,000 mm. Practically, it is difficult to secure serviceable test objects smaller than 0.5 mm. in diameter, but figures for smaller test objects are included.[4] This table

4. For example, the figures for a 0.16/1,000 white stimulus are adapted from Traquair's data for a 0.64/4,000 white stimulus.

will also serve to show that test objects as sensitive as are theoretically possible are not being used.

The sensitivity of a test object is probably a function of its area rather than of its diameter, especially because a slight motion should be imparted to the test object in examining the field on the tangent screen. In table 1 I have indicated the sensitivity of the test objects both as a reciprocal of the visual angle subtended and as a reciprocal of the area of the test object. The true sensitivity probably lies somewhere between the two values shown in the table. I prefer to consider sensitivity as a function of the area, and in using two white test objects the smaller should be from four to one hundred times more sensitive than the larger in most cases.

In table 2 (modified from Traquair) I have given the approximate isopters for red and blue test objects on the tangent screen. It is

TABLE 2.—*Color Fields (Modified from Traquair)*

Stimulus	Color Field Limits, Degrees			
	Out	Down	In	Up
2.5/1,000 red	8	5	8	6
5/1,000 red	13	9	13	8
10/1,000 red	20	13	18	13
20/1,000 red	32	20	20	19
1/1,000 blue	7	6	7	5
5/1,000 blue	27	22	25	20
10/1,000 blue	33	28	32	27

obvious, on comparing tables 1 and 2 that the isopters for a 0.25/1,000 white, a 1/1,000 blue and a 2.5/1,000 red stimulus are approximately the same. The ratio of the areas of these objects is 1 (white) : 16 (blue) ; 100 (red). Also, the isopters for a 1/1,000 white, a 5/1,000 blue and a 20/1,000 red stimulus are approximately the same. The ratio of the areas of these test objects is 1 (white) : 25 (blue) ; 400 (red). Considering the difficulty of comparing different colors and white, there is a relatively close correspondence of the ratios for two different sets of isopters. While there is no physiologic basis for these ratios, yet it may explain the extensive defect for red in diseases of the optic nerve in which there is only a small defect for the 1/1,000 white stimulus.

It has been stated that the tangent screen method of plotting scotomas is unscientific and inaccurate because a given test object subtends a smaller visual angle at the periphery than it does near the fixation point. This is not a great disadvantage, because it increases the sensitivity of the test, and the error is negligible out to the 15 degree circle. Thus, for the screen at 1,000 mm., and taking as normal the fact that a 1

degree test object subtends a diameter of 17.6 mm. at the 5 degree circle, the following values are obtained:

Distance from fixation point	5°	10°	15°	20°	25°
Diameter subtended by a 1° test object	17.6 mm.	18.0 mm.	18.7 mm.	19.8 mm.	21.2 mm.
Linear diameter too small by	..	2.3%	6.0%	11.0%	17.0%
Area too small by	..	4.3%	11.4%	20.9%	40%

Actually, since 1 degree subtends 17.6 mm. at the 5 degree circle and 21.2 mm. at the 25 degree circle, the areas are 309.76 and 449.44, respectively, and the ratio of these areas is 1:1.45. Reference to table 1 will indicate that this error is practically negligible as far as the sensitivity of the test is affected.

For the present, in plotting field defects it is sufficient to state the size of the test object, the distance at which it is used and the illumination. The fixation point should be large enough to be seen. Small test objects should be used first; if no defect is found with these, the field is probably normal. If there is a defect, its slope should be determined. If the conditions under which the field is taken are kept constant, the only variable is the lesion and the field defect it causes, and any changes can be detected at later examinations.

REPORT OF CASES

The following cases are presented (1) because early changes in the visual field either corroborated or established the diagnosis, (2) because the field was important in differential diagnosis or (3) because the data seem to add to the knowledge of the optic pathways. Only lesions as far back as the optic chiasm will be discussed.

INVOLVEMENT OF THE MACULAR REGION

CASE 1.—*Acute edema of the retina.*

F. G., a man of 37, was seen on March 7, 1938, with the complaint of micropsia and cloudy vision of the right eye for one week. The history was otherwise unimportant. Vision in the right eye was 20/20 and was improved with a + 1.00 sphere. The right pupil was larger than the left but reacted normally. In the fundus the retina between the disk and the macula was definitely edematous and elevated 1 diopter, and there was a faint opacity of the vitreous just in front of the macula. On the tangent screen an irregular defect connected with the blindspot could be demonstrated for a 1/1,000 white stimulus (chart 1). A 10/1,000 blue stimulus was not recognized in this scotoma, but a 10/1,000 red stimulus was recognized throughout most of the scotoma. This confirmed the diagnosis of a lesion, which involved perceptive elements of the retina.

This lesion was apparently due to subretinal edema resulting from an abnormal permeability of the choriocapillaris. The condition has been described as idiopathic flat detachment of the retina, acute allergy of the retina and central angiospastic retinopathy. It is probably primarily a disease of the choroid rather than of the retina, as is shown by the defect for color.

The patient was given 100 mg. of sodium nitrite intravenously and told to take 15 mg. of erythrol tetranitrate twice daily. When he returned on March 16 he reported that the micropsia and cloudy vision had disappeared on March 8. At this time (March 16) the vision in the right eye was 20/20, the hyperopic correction was rejected, the fundus was normal and no field defect could be demonstrated.

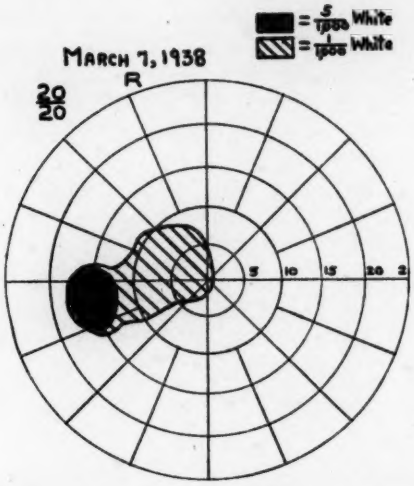


Fig. 1 (case 1).—Right visual field in a case of acute edema of the retina. The defect for a 1/1,000 white stimulus corresponds to the area of subretinal edema. The defect was the same size for a 10/1,000 blue stimulus, while a 10/1,000 red stimulus was recognized everywhere.

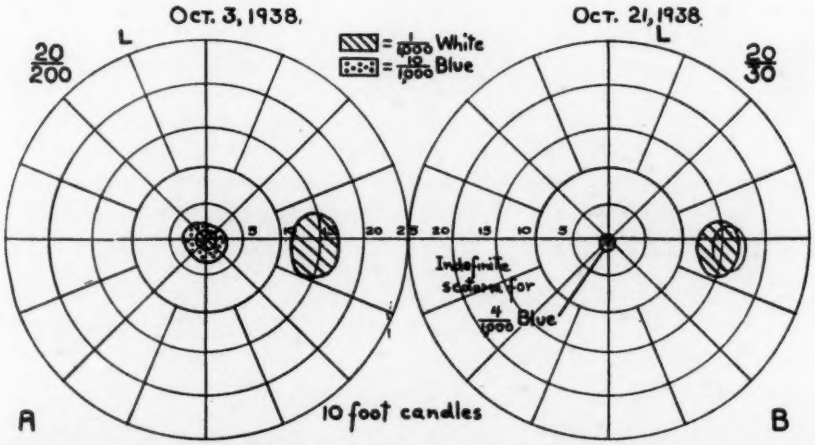


Fig. 2 (case 2).—Left visual fields in a case of chronic edema of the macula. In *A* there is a central scotoma for a 1/1,000 white and a 10/1,000 blue stimulus. The defect for a 10/1,000 red stimulus was the same size as that for a 1/1,000 white stimulus. *B* shows improvement in the scotoma and vision following fifteen daily intravenous injections of sodium nitrite. The defect was elicited with difficulty for a 4/1,000 blue stimulus.

CASE 2.—*Chronic edema of the macula.*

J. L., a man of 55, was seen first on Sept. 26, 1938, with a complaint of progressive diminution of vision in the left eye for two or three years. The vision with a + 2.0 sphere was 20/200. In the macular region a granular area, elevated about 1.5 diopters, was visible. The disk was normal, there were no exudates or hemorrhages and there was moderate arteriosclerosis of the retinal arteries. A field (chart 2 *A*) taken on October 3 showed a small central scotoma for a 1/1,000 white stimulus and a larger one for a 10/1,000 blue stimulus. The defect for a 10/1,000 red stimulus was no larger than for a 1/1,000 white stimulus. The right eye was normal.

Because of the small size of the scotoma and because it could not be elicited with larger white test objects, the prognosis appeared favorable and the patient was given fifteen daily intravenous injections of sodium nitrite. On October 15 the vision was 20/50, and on October 21 it was 20/30. At this time only a small

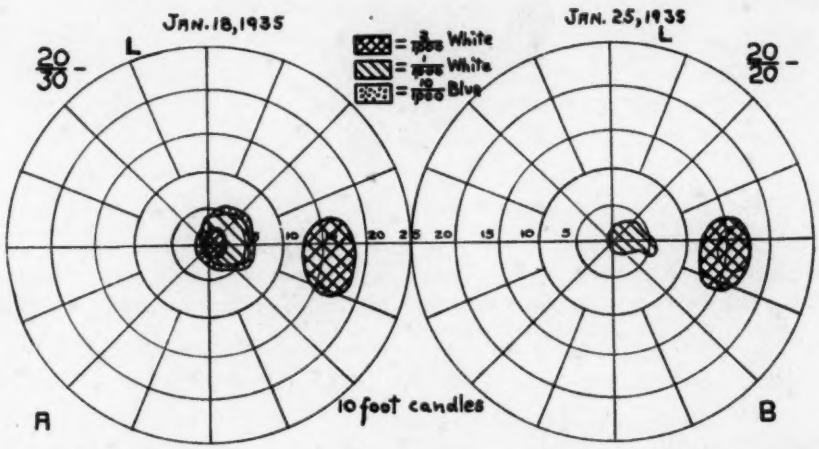


Fig. 3 (case 3).—Left visual fields in a case of disciform degeneration of the macula (early). *A* shows a denser defect than in case 2 for a 2/1,000 white, a 1/1,000 white and a 10/1,000 blue stimulus. The defect for a 5/1,000 red stimulus was the same as for a 10/1,000 blue stimulus. *B* shows improvement in vision and a decrease in the size and density of the scotoma after six intravenous injections of sodium nitrite. The defect was the same for a 1/1,000 white and a 10/1,000 blue stimulus.

central scotoma for a 4/1,000 blue stimulus could be demonstrated (chart 2 *B*). On November 21 the vision was unchanged. The macula still had a faintly granular appearance but was not elevated.

CASE 3.—*Disciform degeneration of the macula (early).*

D. R., a Jewish man of 61, was seen on Jan. 7, 1935, with the complaint of failing vision for three years in the right eye and for four or five months in the left eye.

The vision in the right eye was 5/200, and there was typical disciform degeneration of the macula, elevated 3 or 4 diopters, with circinate retinitis and marked retinal arteriosclerosis.

The vision in the left eye was 20/30— with a + 3.0 diopter lens. At the macula there was an indefinite, disk-shaped grayish area, elevated 2 diopters. The disk was pink, and the retinal vessels were similar to those in the right eye.

The patient had chronic myocarditis and generalized arteriosclerosis, and the dorsalis pedis pulse was absent. The blood pressure was 142 systolic and 90 diastolic, and there had been intermittent claudication for one year.

The left field, taken on January 18 (chart 3 *A*), showed a scotoma for both a 2/1,000 and a 1/1,000 white stimulus. The defects for a 10/1,000 blue and a 5/1,000 red stimulus were the same.

After six intravenous injections of sodium nitrite (100 mg.) the vision improved to 20/20—, and the scotoma became smaller and less dense (chart 3 *B*). This improvement was maintained for one month. On February 27 he complained of sudden loss of sight in the left eye two days previously. At this time there was an oval bluish mass in the macular region surrounded by a few retinal hemorrhages. The vision was 12/200. Three years later the vision was unchanged, and both fundi showed the typical picture of disciform degeneration of the macula. The temporary improvement with vasodilator therapy should offer some hope for future treatment in such cases when the patient is seen in the early stage of the disease.

It is obvious that the conditions in cases 1, 2 and 3 are somewhat similar, except that the onset and response to therapy were different.

In all 3 cases there was an elevation of the retina. In case 1, in which there were an acute onset and slight elevation of the retina in a man of 37, the condition responded rapidly to treatment. In case 2, in which there were a slow progressive development and more elevation of the macula in a man of 55, the response was slower and vision did not reach 20/20, but the improvement was striking. In case 3, in which the patient, a man of 61, had a slow onset but a denser scotoma and a marked circulatory disease, the scotoma did not entirely disappear, but there was sufficient temporary improvement to indicate that the treatment in similar cases should be the same, but for a longer time.

INVOLVEMENT OF THE CHOROID

In my opinion retinitis pigmentosa is due to a slowly progressive obliteration of the choriocapillaris with resulting atrophy of the sensory cells of the retina, a hypothesis first elaborated by Nettleship. The fundus picture and the perimetric findings in the case in which the condition is advanced are too well known to detail here. What of the cases of early involvement in the presymptomatic stage? If a cure is found, these are the lesions which must be discovered and which will stand the greatest chance of improving. The following case illustrates the presymptomic stage:

CASE 4.—*Retinitis pigmentosa, presymptomatic stage.*

M. S., a woman of 24, was examined because her mother had a case of advanced retinitis pigmentosa. The patient had no ocular or visual complaints. All suggestive and leading questions brought a negative response. The vision was 20/20

in each eye, and the perimetric fields (4/250 white stimulus) were normal. Careful examination of the fundi revealed several tiny flecks of pigment in the lower nasal portion of the retina. The choroidal markings were slightly blurred, and there was a faint (?) whitish reflex. The optic nerve was normal, and the retinal vessels were within normal limits. A tangent screen field (chart 4) showed normal blindspots, a slight contraction of the fields up and out for a 1/1,000 and a 2/1,000 white stimulus and a definite contraction of the color fields, with the blue field relatively more contracted than the red field. Six months later there was no obvious increase in the field defects.

This field is shown because there are demonstrable changes without any symptoms and with such slight (?) changes in the fundus that, without the corroborative evidence obtained with the tangent screen, this patient would probably be called normal. With the perimeter no deviation from the normal could be detected!

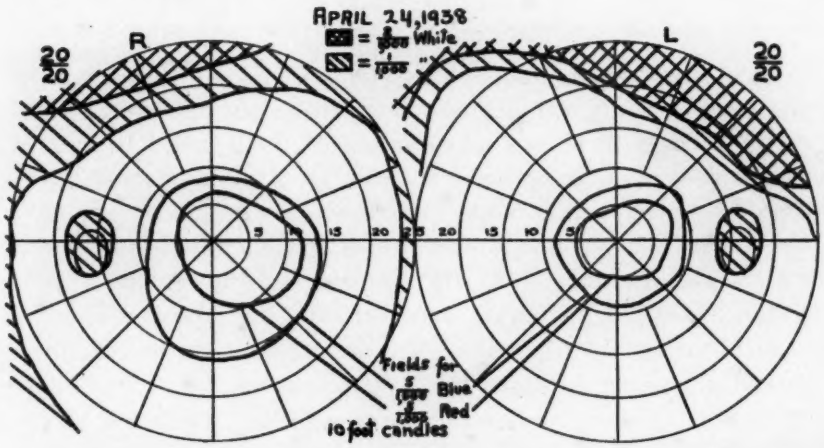


Fig. 4 (case 4).—Visual fields in a case of retinitis pigmentosa, presymptomatic stage. There was definite contraction of isopters for a 1/1,000 and a 2/1,000 white stimulus in the upper temporal quadrants. The field for a 5/1,000 blue stimulus was smaller than for a 5/1,000 red stimulus. No defect could be elicited on the perimeter with white test objects.

CASE 5.—*Acute choroiditis (juxtapapillaris).*

C. B., a Spanish woman of 23, was seen on Nov. 7, 1938, with the complaint of sudden loss of sight in the left eye, discovered on awakening on November 2. The past history was unimportant except for the fact that the patient had been having her tonsils removed by electrocoagulation.

The vision in the left eye was 8/200. In the fundus there was a patch of acute choroiditis under the inferior temporal vessels close to the disk. The vessels were obscured by the edema, and the lower pole of the disk was also involved in the edema. The field showed an arcuate defect (chart 5 *A*) continuous with the blindspot for a 10/1,000 white stimulus. The slope was steep. The fixation point was involved by the defect for a 1/1,000 white stimulus.

On Jan. 15, 1939, after the lesion had healed, the vision was 20/20. About ½ disk diameter down and out from the disk, under the inferior temporal artery,

there was a small white spot about one sixteenth the diameter of the disk. The field at this time (chart 5 *B*) showed an absolute arcuate defect, with a steep edge.

This field is presented to show the similarity of the field defect to the arcuate defect often found in cases of chronic glaucoma. The same bundle is often involved in glaucoma, and this may be due to the fact that this bundle lies under the inferior temporal artery at the margin of the disk. Similar defects have been mentioned by Roenne, Traquair, Abraham and others.

DEFECTS DUE TO EARLY GLAUCOMA

CASE 6.—*Angioscotoma due to glaucoma.*

R. E., a woman of 58, was seen early in December 1937, with the complaint of a film before the right eye and headaches at night for several weeks. The vision was 20/100 in the right eye and 20/30 in the left eye. Nuclear cataracts were

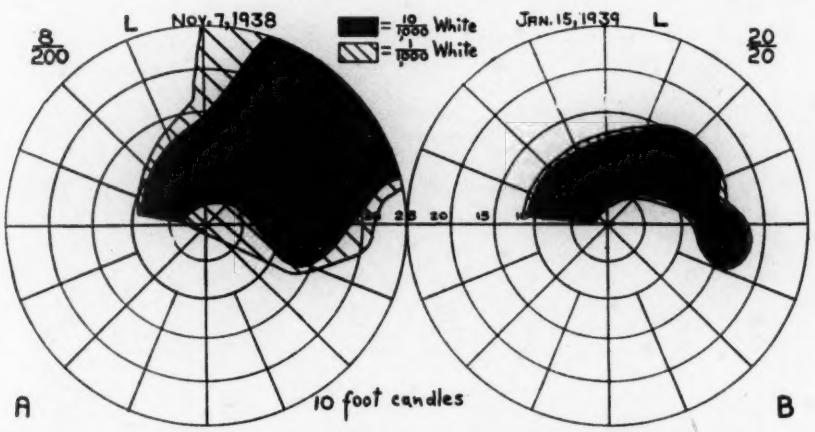


Fig. 5 (case 5).—Left visual fields in a case of acute choroiditis of the juxtapapillary type. *A* shows a dense scotoma for a 10/1,000 white stimulus. The surrounding edema involved the macular fibers as shown by the defect for a 1/1,000 white stimulus. The defects for a 10/1,000 red and a blue stimulus were approximately the same size as for the 1/1,000 white stimulus. *B* shows an absolute arcuate defect for a 10/1,000 white stimulus which remained after the lesion had healed. This indicates complete destruction of a small nerve bundle due to secondary retinal involvement.

present, accounting for the lowered vision. The right optic nerve had a deep physiologic cup, and there was arterial pulsation, with a bend in one artery as it passed from the disk. The tension was 40 in the right eye.

On December 17 the tension in the right eye was 30. A small but definite angioscotoma was easily demonstrated at this time (chart 6 *A*). On December 28 the tension was 38, and at this time the angioscotoma was definitely longer (chart 6 *B*). Small test objects were necessary to demonstrate these defects.

CASE 7.—*Early arcuate scotoma of glaucoma.*

E. R., a man of 56, was operated on the left eye by Dr. Arnold Knapp for subacute glaucoma in November 1936. The field defect in the left eye (chart 7),

which had been present before operation, was present ten months later. This defect was the same size for a 1, 2 and 5 mm. white object.

In September 1937 prodromal attacks developed in the right eye. The patient was seen on September 23. The tension was 36. At this time he had a definite arcuate scotoma only for a 0.5/1,000 white stimulus, with nucleus for a 1/1,000

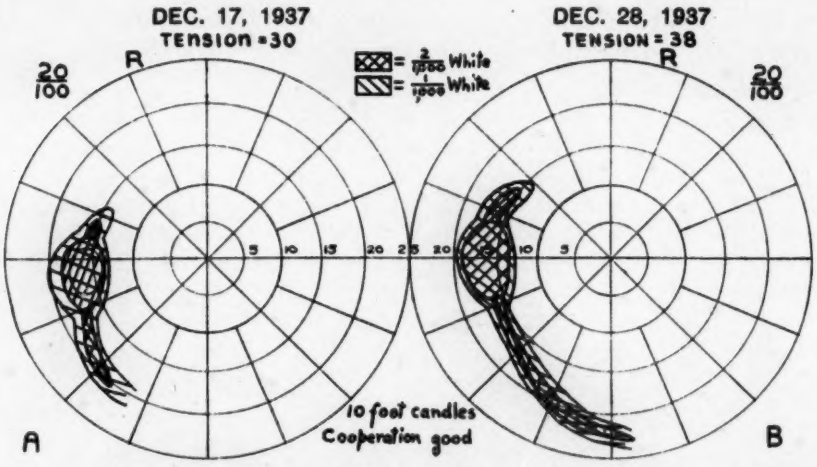


Fig. 6 (case 6).—Right visual fields showing a defect due to early glaucoma. There was an angioscotoma, which increased with a rise in tension.

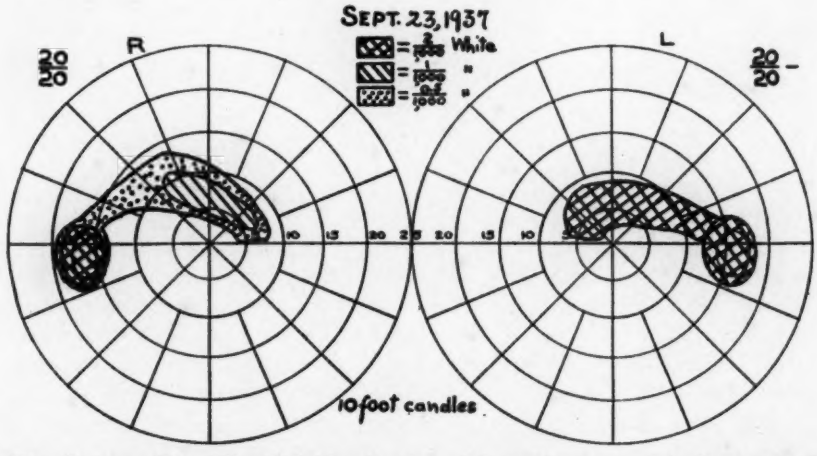


Fig. 7 (case 7).—Visual fields showing defects due to early glaucoma. The right eye shows an arcuate defect for a 0.5/1,000 white stimulus with a nucleus (?) for a 1/1,000 white stimulus. This scotoma disappeared after a successful trephining. The left shows an arcuate defect for a 2/1,000 white stimulus which was also the same size for a 5/1,000 white stimulus. This scotoma remained after a successful trephining and has been unchanged during two years of observation.

white stimulus but not for a 2/1,000 white stimulus (chart 7). Trephining was done on September 24 by Dr. Knapp. On December 4 only a trace of the scotoma was left, and on April 4, 1938, the field of the right eye was entirely normal.

CASE 8.—*"Baring" of the blindspot in glaucoma.*

Mrs. H. A. F., a woman of 47, was seen in July 1934. For eight months she had had attacks of pain in the left eye, with blurred vision, haloes, nausea and occasional vomiting. These attacks occurred at the movies and were relieved by a night's sleep. The patient had a high compound hyperopic astigmatism with corrected vision of 20/13 in each eye, the anterior chambers were shallow and there was a deep physiologic cup in each eye, with venous pulsation in the left eye. The tension was 22 in the right eye and 33 in the left eye. The left field showed only a defect in the upper nasal quadrant for a 0.5/1,000 white stimulus and a slight nasal contraction for a 1/1,000 white stimulus.

The tension was kept within normal limits until Dec. 3, 1935. At this visit she reported three recent attacks in the left eye. The tension at this time was 28 in the left eye, and the field (chart 8) showed a slight increase in the defect for a 0.5/1,000 white stimulus with "baring" of the blindspot (first described by Traquair) for this stimulus and a questionable contraction up and in for a 1/1,000 white stimulus, similar to that present at her first visit.

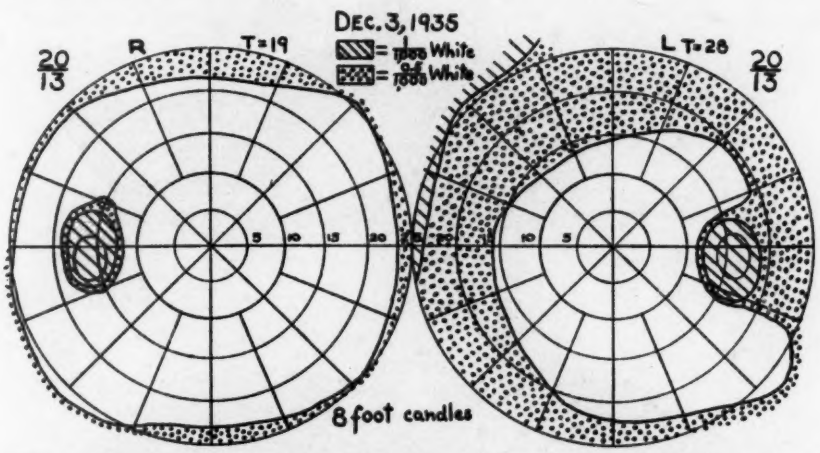


Fig. 8 (case 8).—Visual fields showing defects due to early glaucoma. In the right eye there was a normal blindspot and a normal isopter for a 0.5/1,000 white stimulus. In the left eye there was "baring" of the blindspot for a 0.5/1,000 white stimulus due to contraction of this isopter.

The field of the right eye, in which the tension has always been normal, is also shown in chart 8 for comparison with the field of the left eye.

This case is presented because the defect in the upper nasal field has always been present and did not increase until the patient had a slight rise in tension, at which time there was a contraction of the isopter for a 0.5/1,000 white stimulus. Such a field defect could not be demonstrated on the perimeter or even on the tangent screen without a 0.5/1,000 white stimulus.

Cases 6, 7 and 8 demonstrate three different types of field defects found in cases of early glaucoma. Each is produced by a rise in intraocular tension, but the mechanism of the production of each is probably different.

DISEASE OF THE OPTIC NERVE

CASE 9.—*Acute retrobulbar neuritis associated with closure of the superior branch of the central retinal artery.*

G. G., an Italian girl of 13, a patient of Dr. Arnold Knapp, was seen on Dec. 22, 1937, with the complaint of sudden loss of sight in the left eye nine days earlier.

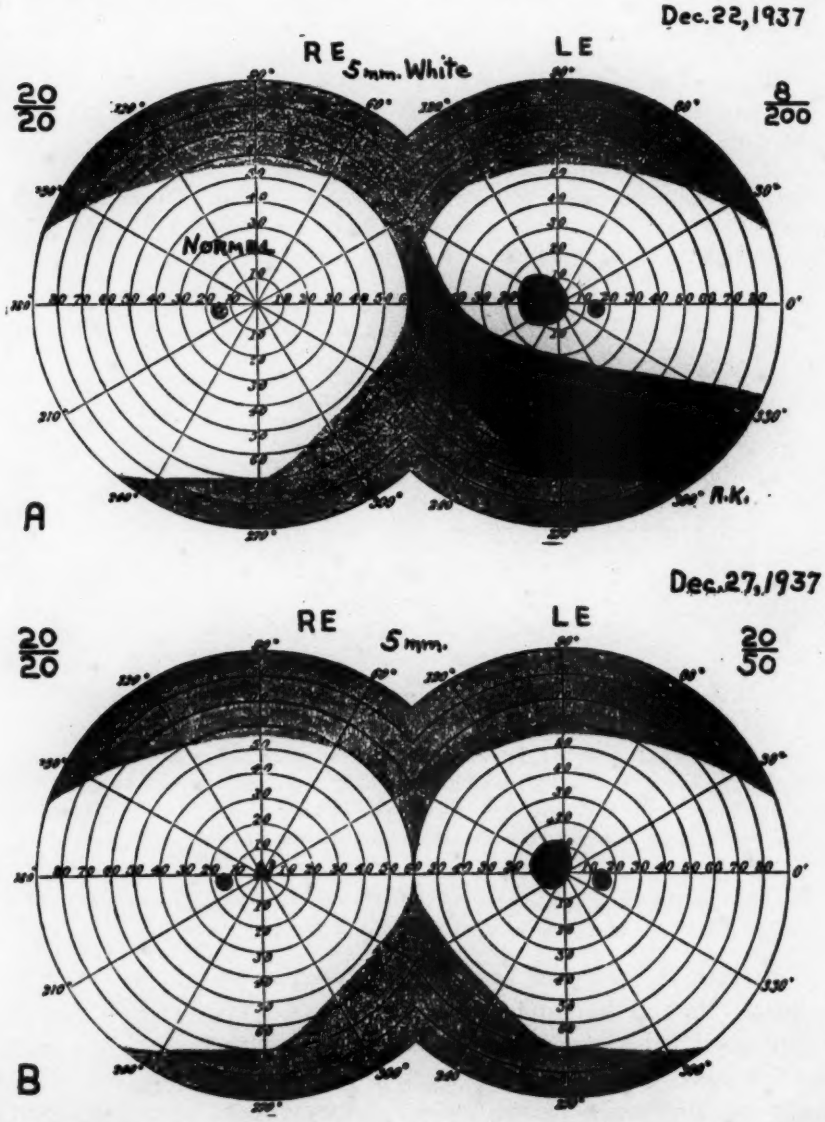


Fig. 9 (case 9).—Visual fields in a case of acute retrobulbar neuritis associated with partial closure of the superior branches of the central retinal artery. *A*, field taken by confrontation on Dec. 22, 1937. There are two separate and distinct field defects unconnected with each other or with the blindspot. *B*, field taken by confrontation on December 27, after five intravenous injections of sodium nitrite. The retinal angiospasm had disappeared with a corresponding loss of the defect in the lower field.

Although all examinations gave negative results, operation on the sinuses had been advised.

Vision in the left eye was 8/200. The retinal veins were engorged, and the superior retinal arteries were extremely narrowed and did not pulsate when pressure was made on the globe. The upper pole of the disk was blurred, and there was edema of the macula and the adjacent retina above the macula with a typical cherry red spot at the macula. The field (chart 9 *A*) showed a paracentral scotoma involving the fixation point and an absolute defect in the lower half of the lower field. The right eye was normal.

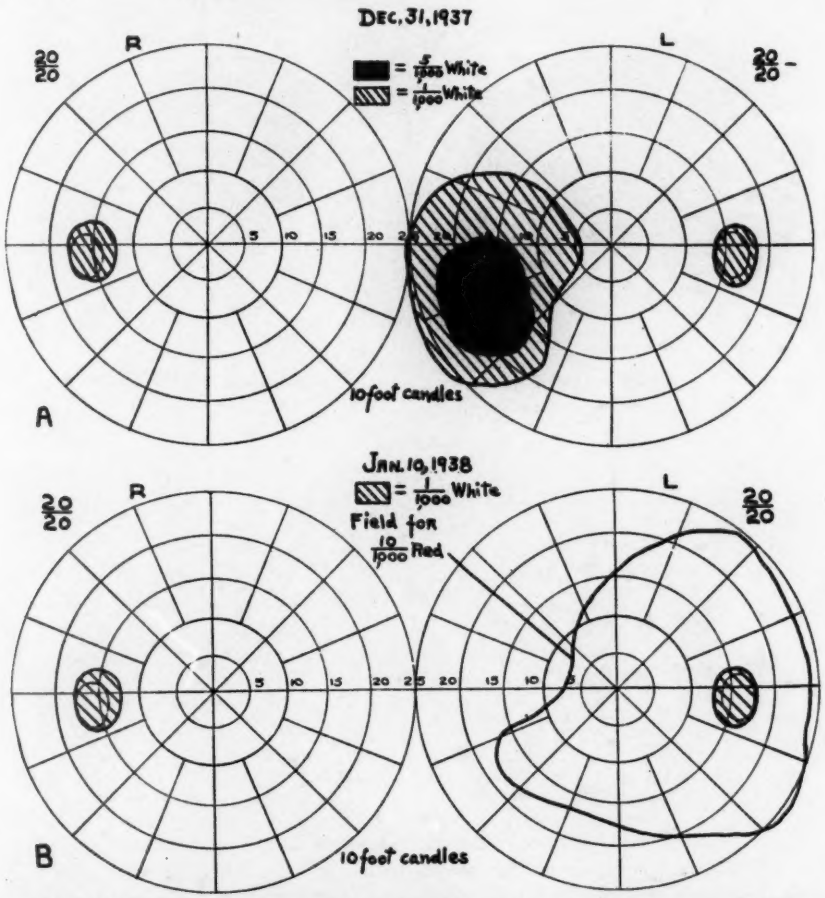


Fig. 10 (case 9).—*A*, field taken on December 31. Vision improved to 20/20—, and the paracentral scotoma had decreased in size with continuation of the injections of sodium nitrite. *B*, field taken on Jan. 10, 1938. The field is normal except for a contraction in the nasal field of the isopter for a 10/1,000 red stimulus. This eventually became normal.

With daily intravenous injections of sodium nitrite (previously shown to be of value in retrobulbar neuritis [5] and closure of the central retinal artery [6]) the

5. Duggan, W. F.: Use of Vasodilators in Treatment of Retrobulbar Neuritis, Arch. Ophth. **16**:380 (Sept.) 1936.

6. Esterman, B.: New York State J. Med. **37**:296 (Feb. 1) 1937.

closure of the retinal vessel and the defect in the lower field disappeared by the fifth day, the scotoma was smaller (chart 9 *B*) and vision was 20/50. On the ninth day vision was 20/20— and the scotoma was much smaller (chart 10 *A*). Treatment was stopped. Ten days later the field was normal except for a nasal constriction of the red field (chart 10 *B*). This improvement has been maintained thus far.

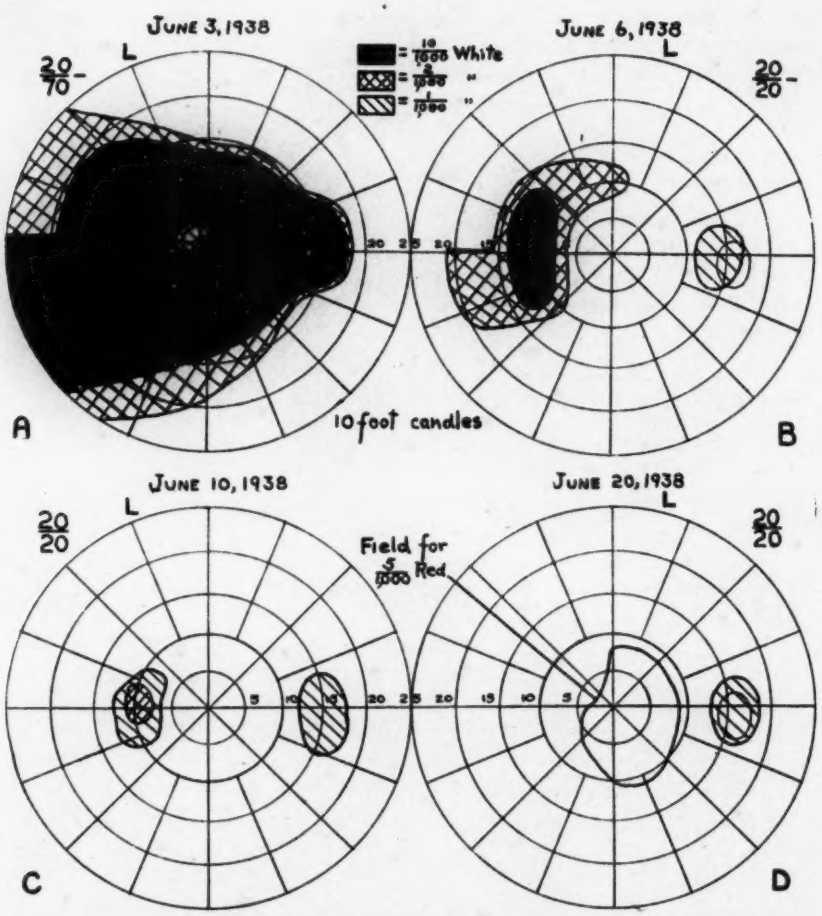


Fig. 11 (case 10).—Visual fields in a case of acute retrobulbar neuritis, in which the lesion was close to the lamina cribrosa. On May 31, 1938, the vision was limited to perception of hand movements, and there was a papilledema of 3 diopters. Intravenous injections of sodium nitrite were begun. On June 3 there was a dense central defect which seemed to be composed of two arcuate defects, as shown in *A*. *B*, *C* and *D* show continued improvement in vision with corresponding improvement in the field.

The marked progressive and rapid improvement with vasodilator therapy of two distinct lesions, one of which was due to visible arterial closure and the other of which could be attributed to closure of a small vessel in the optic nerve, because of the excellent response of both to

this therapy adds further proof to the hypothesis that in most cases acute retrobulbar neuritis is of angiospastic origin.

Tillé and Héry [7] have reported a similar case in which improvement occurred with acetylcholine.

CASE 10.—*Retrobulbar optic neuritis at the level of the lamina cribrosa.*

H. R., a woman of 28, complained of blurred vision in the left eye on May 30, 1938. On May 31 she was seen by Dr. Hobart Agnew, who found vision limited to

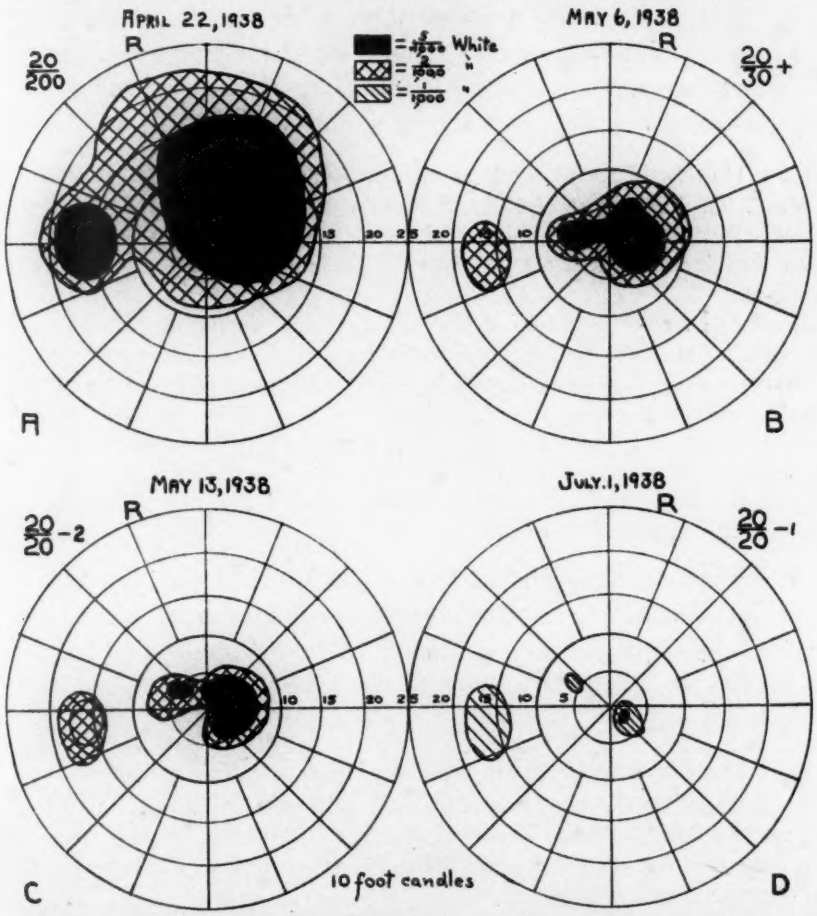


Fig. 12 (case 11).—Visual fields in a case of acute retrobulbar neuritis in which the lesion was in the posterior part of the optic nerve (second attack). These fields (*A, B, C* and *D*) show the progressive improvement in vision and a decrease in the scotoma with vasodilator therapy. The scotoma finally broke up into two parts (*D*). It is assumed that the denser of the two resulting scotomas was a remnant of the first attack, three years prior to the present attack.

perception of hand movements in the periphery of the field and a papilledema of 3 diopters. The past history was unimportant except for a head cold three weeks prior to the onset of visual loss. Vasodilator therapy was instituted at once. I

7. Tillé, H., and Héry, J.: Bull. Soc. d'opht. de Paris, June 1934, p. 290.

saw the patient on June 3. Vision was 20/70—, the disk was blurred but not elevated and the field (chart 11 *A*) showed a variation of a ring scotoma or a double arcuate scotoma with a nasal step. On June 6, after the seventh intravenous injection of sodium nitrite, the vision was 20/20—, and the scotoma was limited to the nasal field (chart 11 *B*). On June 10 vision was 20/20, the scotoma was much smaller (chart 11 *C*) and the disk appeared normal. On June 20 the only field defect was a nasal contraction of the red field (chart 11 *D*), with questionable temporal pallor.

In this case the lesion is placed close to the lamina cribrosa because of the intense papilledema and because the nerve fibers involved were still similar in arrangement anatomically to their distribution on the retina, as shown by the shape of the scotoma.

CASE 11.—*Retrobulbar neuritis in the posterior part of the optic nerve.*

M. P., an Italian girl of 19, had acute retrobulbar neuritis in the right eye in 1935. She was seen two weeks after the onset, with vision of 8/200. Her vision then improved to 20/30 in twenty days, and temporal pallor of the disk developed.

On April 9, 1938, the vision in the right eye began to fail again. By April 22 it was 20/200, the field showed a large central scotoma (chart 12 *A*) and the fundus was normal except for temporal pallor of the disk (due to the attack in 1935). With vasodilator therapy, the vision improved to 20/30+ by May 6, and the scotoma (chart 12 *B*) was not only much smaller but showed signs of breaking into two parts. With continued treatment the vision improved to 20/20—2 by May 13 and the scotoma showed two nuclei (chart 12 *C*). On July 1 only two tiny scotomas remained (chart 12 *D*).

In my opinion the larger scotoma represents the blood vessel involved in the first attack of retrobulbar neuritis, and the smaller one represents the fresh lesion of the second attack. On the basis of two attacks of retrobulbar neuritis, the neurologist considered that this patient had multiple sclerosis.

CASE 12.—*Chiasmal retrobulbar neuritis; atrophy of the optic nerve.*

E. B., a girl of 17, was seen on Dec. 13, 1937, with the history that vision in each eye had failed markedly during a week in October 1936. It improved slightly during the next ten months and had been essentially unchanged since then. There was no other pertinent history.

The vision was 10/200 in each eye, there was marked temporal primary atrophy of the optic nerve and a fairly dense cecocentral scotoma (chart 13 *A*). The patient was examined several times during the next month, and refraction was done. There was no improvement in the vision. Examination of the nose and throat gave negative results, and the neurologic examination gave negative results except for a few indefinite symptoms of multiple sclerosis.

I saw the patient for the first time on Jan. 17, 1938. Because of the sloping edge of the scotomas, a favorable prognosis was given. With intensive treatment with sodium nitrite intravenously, the vision had improved to 20/40 by February 2 and to 20/20— and 20/30 by February 13, with a corresponding improvement in the scotomas. On March 13 the vision was unchanged and there was a marked decrease

in the scotomas (chart 13 *B*). After this date the patient was given erythrol tetranitrate until June 10. On September 16 the vision was 20/20— in each eye, the scotomas of March 13 were still present and the disks were definitely pinker than when the patient was first seen.

This case is shown (1) because the lesion was probably in the posterior part of the chiasm, giving field defects similar to those of tobacco amblyopia, and (2) because there was atrophy of the optic nerve with

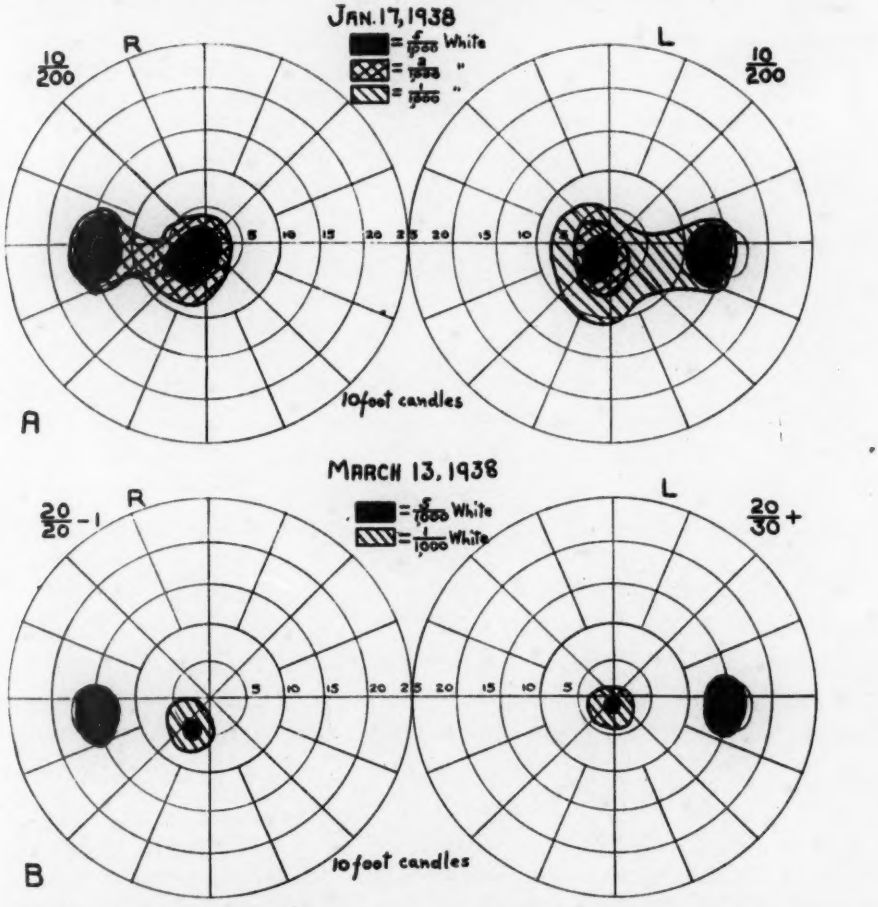


Fig. 13 (case 12).—Visual fields in a case of bilateral atrophy of the optic nerve following a chiasmal retrobulbar neuritis. *A*, fields taken on Jan. 17, 1938, fifteen months after loss of sight in both eyes. The scotomas resemble those found in cases of tobacco amblyopia. Because of the shallow slope of the scotomas, a favorable prognosis was given. *B*, fields taken on March 13, after intense vasodilator treatment with intravenous injections of sodium nitrite for one month. The vision was 20/20— and 20/30 on February 13. These fields show a marked decrease in the size and density of the scotomas.

impaired vision of fifteen months' duration; however, because of the characteristics of the scotomas, a favorable prognosis was given to the patient before treatment was started.

The scotomas of tobacco amblyopia are easily recognized. The bilateral cecocentral or paracentral scotomas for a white test object, with disproportionately larger defects for red, are typical. I have seen patients with vision of 20/20 — for whom the scotoma could be demonstrated only with a 0.5/1,000 white stimulus and patients with vision of 5/200 for whom the scotoma could be demonstrated with a 10/1,000 white stimulus.

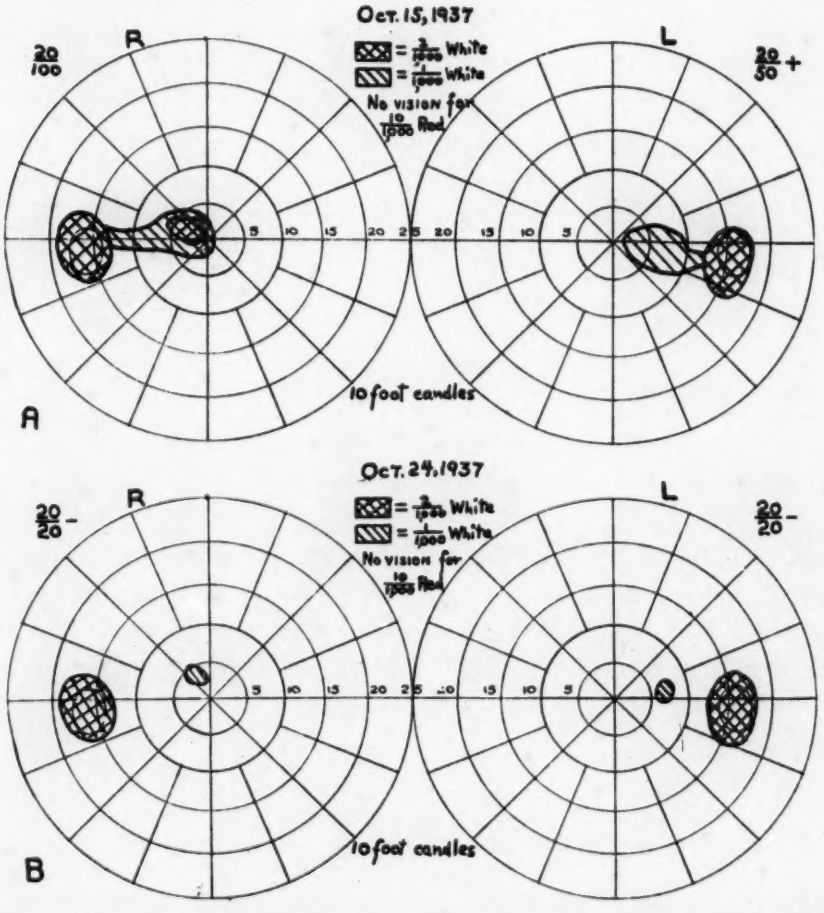


Fig. 14 (case 13).—Visual fields in a case of tobacco amblyopia and syphilis. *A*, typical cecocentral scotomas of tobacco amblyopia. *B*, fields taken nine days later, after seven intravenous injections of sodium nitrite. At this time the patient could not recognize a 10/1,000 red stimulus anywhere in the field.

Other conditions can give somewhat similar field defects (cases 12 and 14), and it is probable that tobacco can cause retinal or choroidal angiopathy. The following case is described because scotometric examination revealed the correct diagnosis.

CASE 13.—*Tobacco amblyopia and syphilis.*

L. J., a Negro of 39, was seen at the clinic on Sept. 24, 1937, with the complaint of failing vision for four months. The vision was 20/50 and 20/50 +, the pupils reacted sluggishly to light, there was temporal pallor of the disks and the retinal circulation was normal. Red and green were not recognized, and there were paracentral scotomas. The Wassermann reaction of the blood was 4 +. The patient had smoked six or more cigars daily for twelve years.

On October 15 I examined the patient. The vision was now 20/100 and 20/50 +. With the tangent screen it was possible to demonstrate cecocentral scotomas, more advanced for the right eye, where the scotoma had a definite nucleus. A 10 mm. red object was not recognized anywhere in either field (chart 14 *A*). The findings were typical of tobacco amblyopia.

The patient received seven intravenous injections of sodium nitrite in eight days. On October 24 the vision was 20/20 — 2 in each eye, and only a trace of the scotoma could be demonstrated (chart 14 *B*). Vision for red was still absent at this time.

The patient was then referred elsewhere for antisyphilitic treatment. When he was seen last, on Aug. 3, 1938, the vision was 20/20 in each eye, and the fields were entirely normal for white and red.

This case is particularly important because, with pale disks, absence of vision for red, sluggish pupils and a positive Wassermann reaction, one might feel justified in making a diagnosis of early syphilitic atrophy of the optic nerve. Either syphilitic therapy would have been started without any immediate improvement in vision, or the arsenicals would have been withheld because of their supposed deleterious effects on the optic nerves.

This case demonstrates that with a positive Wassermann reaction all pathologic involvement present is not necessarily of syphilitic origin. However, it cannot be denied that the presence of syphilis may make a person more sensitive to other toxins. Neither do I wish to state that syphilis cannot cause a clinical picture which is similar to that of tobacco amblyopia.

CASE 14.—*Pituitary tumor.*

D. G., a Negro man of 39, was seen in May 1934 with the complaint of failing vision and headaches for six months. For many years he had smoked thirty cigarets daily. The vision was 20/200 and 10/200. There was temporal atrophy of the optic nerve. The Wassermann reaction of the blood was negative, and examination of the spinal fluid gave negative results. A central scotoma was found; so the patient was referred to me as having tobacco amblyopia.

On July 12 I saw the patient and repeated the examination of the fields. The result (chart 15) showed that this patient had bitemporal central hemianopic scotomas with a complete bitemporal hemianopia for red.

A stereoroentgenogram of the skull showed thinning of the floor of the sella turcica and decalcification of the dorsum sellae. This report plus the fields located the lesion in or near the pituitary body. The patient could not be induced to enter a neurologic hospital for further study.

In this case the field defect could easily have been misinterpreted as due to tobacco if care had not been taken in plotting the scotomas. In fact, that diagnosis was made on the basis of the first examination of the fields. Only careful attention to small details brought out the typical hemianopic features of the defects.

Since these scotomas have the approximate size and position of those found in tobacco amblyopia and involve the papillomacular fibers, it lends support to the hypothesis that the lesion of tobacco amblyopia is located in the posterior part of the chiasm where the macular fibers cross and where a single lesion must cause defects in the visual fields of both eyes.

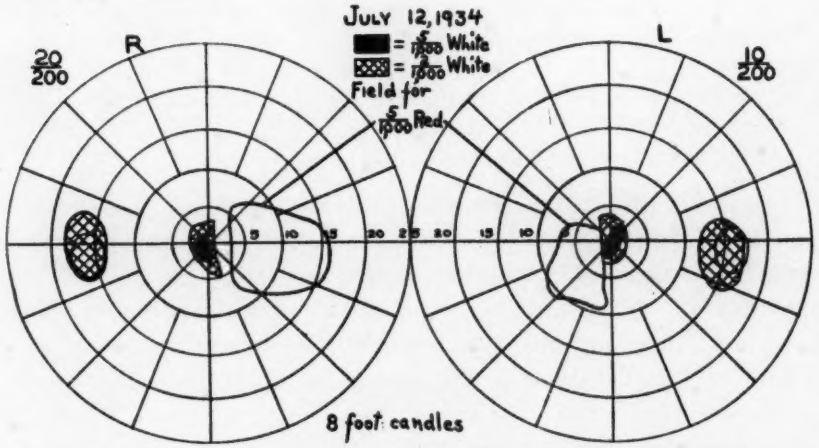


Fig. 15 (case 14).—Visual fields in a case of pituitary tumor and atrophy of the optic nerve. There were bitemporal hemianopic central scotomas for a 5/1,000 and a 2/1,000 white stimulus and bitemporal hemianopia for a 5/1,000 red stimulus. Because the patient used tobacco, the condition in this case had been diagnosed as tobacco amblyopia, following study of a field taken elsewhere. Careful attention to the nasal edge of the scotoma gave the clue to the correct diagnosis. This was confirmed by a roentgenogram.

COMMENTS AND CONCLUSIONS

Tangent screen scotometry is the only diagnostic procedure with which one can detect and locate small lesions or early lesions in the visuosensory system.

The sensitivity of this test depends on the use of test objects subtending small visual angles. This can be attained by moving the screen away from the eye and by using tiny test objects. There is a practical limit to the size of test objects which can be procured so that the minimum distance at which the screen should be placed is about 1 meter.

The practice of scotometry demands a knowledge of the anatomic structure and physiologic function of the eye, the optic nerves and tracts

and the optic radiations. Furthermore, one must know the types of field defects found in lesions of the rods and cones, retina and optic nerves in order to plot and interpret fields correctly.

Perimetric, and more particularly, scotometric tests should not be entrusted to technicians. It is just as logical to depend on technicians to examine the fundi. Scotometric examination is not a simple routine measure like doing blood counts or Wassermann tests of the blood. Each case presents an individual problem; no single routine is applicable in all cases.

Fields have been presented for a number of cases. In many of these cases the perimetric findings were normal. In others, careful scotometric examination was the essential factor in making the correct diagnosis or in evaluating or corroborating the results of therapy.

CYCLOPLEGIA AND MYDRIASIS BY USE OF ATROPINE, SCOPOLAMINE AND HOMATROPINE-PAREDRINE

JAMES MARRON, M.D.
CHICAGO

This investigation was undertaken to determine for atropine sulfate, scopolamine hydrobromide and a combination of homatropine hydrobromide and paredrine [1] the following points: (1) the length of time necessary for the induction of complete cycloplegia and mydriasis, (2) the time of occurrence and the amount of the minimum range of accommodation and maximum mydriasis, (3) the duration of maximum cycloplegia and mydriasis and (4) the length of time necessary after instillation of cycloplegia (*a*) for ability to do close work and (*b*) for return to the normal range of accommodation and normal pupillary diameter.

REVIEW OF LITERATURE

Innumerable drugs and combinations of drugs for the production of cycloplegia have been used in the past one hundred and twenty-eight years since William Wells [2] in 1811 first described the effect of a medicine on the "power of the eye to adapt to near objects." Many times as a young man he had applied the juice of the herb belladonna to one or the other of his own eyes and noted its mydriatic effect. Wells prevailed on young Dr. Cutting to use belladonna in one of his eyes and to note particularly its effect on the power to adapt his eye to near objects. With the reflection of a candle flame in a thermometer bulb as the test object, Cutting found his left near point to be 6 inches (15 cm.). In one-half hour after the application of the juice of the herb belladonna, when the pupil was but little dilated, his near point was 7 inches (18 cm.). Fifteen minutes later this point had receded to 3½ feet (107 cm.). When the pupil was fully dilated the test object was blurred at a distance of 8 feet (244 cm.). However, far distant objects were clear. This complete effect continued until the next day,

From the Department of Surgery, Division of Ophthalmology, of the University of Chicago.

1. Paredrine is a proprietary name for a sympathomimetic drug (4-hydroxy-α-phenyl-β-aminopropane; β-4-hydroxylphenylisopropylamine).

2. Well, W. C.: Observations and Experiments on Vision, Phil. Tr. Roy. Soc., London **101**:378, 1811.

and it was not until the ninth day that he had completely recovered the adaptive power of his eye. The pupil remained somewhat dilated a slightly longer time.

Lussana [3] in 1852 was the first to study the effect of atropine on the eyes as part of a general systemic study of its therapeutic action. He found that after large doses orally the pupil dilated, vision became blurred and the ability to do near work was entirely lost. This ability returned about two days after cessation of the drug, and the pupil was normal after eight days.

These original findings with atropine were augmented with variable results on a small scale by Zehender [4] in 1856, who studied 2 eyes; Donders [5] in 1864 reported the experiment on the eyes of Dr. Hamer, his assistant; Oliver [6] in 1881 reported studies on 10 young emmetropic eyes, and Schäfer [7] in 1881 studied 3 eyes. However, Feddersen [8] in 1884 made a rather extended study on 76 eyes. He instilled 1 drop of a 1 per cent solution of atropine sulfate into each eye and made repeated measurements of the near point and the diameter of the pupil. He found the cycloplegic effect beginning in twelve to eighteen minutes and reaching its maximum in one hundred and six minutes. The accommodative power began to return in forty-two hours and was back to normal in eight days, maintaining this level to the fourteenth day, when the last observations were made. The mydriatic effect began in twelve minutes and was complete in twenty-six minutes. The pupil began to return to normal in two days and was normal in ten.

Homatropine cycloplegia was studied in 1881 by Oliver,[6] Schäfer [7] and Risley.[9] They agreed that full mydriasis was reached in thirty minutes and passed off in twenty-four to forty-eight hours. Cycloplegia

3. Lussana, F.: Dell'azione e delle virtù terapeutiche dell'atropina e della belladonna, Ann. univ. di med. **140**:514, 1852.

4. Zehender, W.: Beobachtungen bei artificieller Mydriasis, Arch. f. Ophth. (pt. 2) **2**:95, 1856.

5. Donders, F. C.: Accommodation and Refraction of the Eye, translated by W. D. Moore, London, New Sydenham Society, 1864, p. 584.

6. Oliver, C. A.: The Comparative Action of Hydrobromate of Homatropine and of Sulphate of Atropia upon the Iris and Ciliary Muscle, Am. J. M. Sc. **82**: 150, 1881.

7. Schäfer, H.: Vergleichende Untersuchungen über die Wirksamkeit des Atropin, Duboisin und Homatropin auf das Auge, Arch. f. Augenh. **10**:186, 1881.

8. Feddersen, I. M.: Beitrag zur Atropinvergiftung, Inaug. Dissert., Berlin, O. Francke, 1884; cited by Lewin, L., and Guillery, H.: Die Wirkungen von Arzneimitteln und Giften auf das Auge, Berlin, A. Hirschwald, 1913, vol. 1, p. 155.

9. Risley, S. D.: The Value of Homatropine Hydrobromate in Ophthalmic Practice, Am. J. M. Sc. **82**:113, 1881.

occurred in an hour, lasting slightly more than an hour, and accommodation was normal in sixteen to thirty hours.

The efficacy of scopolamine hydrobromide as a cycloplegic was reported by Vierling [10] and Martelli [11] in 1893. They each used 0.1 and 0.2 per cent solutions of the hydrobromide. Martelli, after a study of an unstated number of eyes, and Vierling, after observations on 8 eyes, agreed that mydriasis began in ten to twelve minutes and reached its full effect in thirty minutes, maintaining this for thirty hours with a gradual return to normal by the fourth to sixth day. The cycloplegic effect observed first after eleven minutes was complete in forty-five minutes. The maximum effect lasted twenty-five hours, and normal accommodative power returned in seventy-two to ninety-six hours. Reber [12] in 1908, after using a combination of scopolamine and cocaine on 1,000 eyes, and Marlow [13] in 1911, after using scopolamine over a period of ten years, reported a distinct superiority over atropine in refraction work. This is exactly the opposite to Bothman's [14] results on 200 eyes (1937).

The homatropine-cocaine combination was introduced in 1887 by Lang and Barrett.[15] They found that dilatation of the pupil in 6 cases began in ten minutes, reached its maximum in thirty minutes and completely passed off in thirty-four hours. The near point began to recede in seven minutes, reached its maximum distance in sixty-two minutes and had returned to normal in nine hours. In 1909 Cruise [16] reported on a series of 140 eyes in which the homatropine-cocaine combination instilled four times was superior as a cycloplegic to a 1 per cent solution of atropine used three times daily for three days. Horovitz,[17] on the basis of 25 cases, in general substantiated the time relations found by

10. Vierling, F.: Ueber die Wirkung des Scopolamin hydrobromicum, Beitr. z. Augenh., 1894, no. 13, p. 1.

11. Martelli, P.: Sulla scopolamina, Arch. di ottal. **1**:63, 1893.

12. Reber, W.: Comparative Potency of Hyoscin and Scopolamine Hydrobromide in Refraction Work, J. A. M. A. **50**:1323 (April 25) 1908.

13. Marlow, F. W.: Note on the Efficiency of One Installation of Scopolamine as a Cycloplegic for Refraction Work, Ophth. Rev. **30**:74, 1911.

14. Bothman, L.: Refractive Errors in the Same Eyes While Under the Influence of Homatropine, Scopolamine and Atropine, Tr. Am. Acad. Ophth. **42**:822, 1937.

15. Lang, W., and Barrett, J.: The Action of Myotics and Mydriatics on the Accommodation, Roy. London Ophth. Hosp. Rep. **11**:219, 1887.

16. Cruise, R. R.: The Abuse of Atropine in Refraction Work, Tr. Ophth. Soc. U. Kingdom **29**:245, 1909.

17. Horovitz, I.: Der Einfluss von Kokain und Homatropin auf Akkommodation und Pupillengrösse, Ztschr. f. Augenh. **28**:530, 1912.

Lang and Barrett. The fact that there is a synergistic action between homatropine and cocaine was demonstrated by Naito [18] on his own eyes.

Following the lead of Myerson and Thau [19] in 1937, Beach and McAdams[20] in two reports demonstrated the cycloplegic efficiency of a 5 per cent solution of homatropine or a 1 per cent solution of atropine with a 1 per cent solution of benzedrine sulfate. These findings were confirmed by Rutherford,[21] Powell,[22] Berens [23] and Sudranski.[24] With this combination, peak cycloplegia was reached in fifty to seventy minutes, quickly passing off so that patients could read by evening and had a normal near point in eighteen hours. Abbot and Henry [25] introduced the use of paredrine,[1] and Tassman,[26] using a combination of 4 or 5 per cent homatropine hydrobromide and 1 per cent paredrine, obtained satisfactory cycloplegia which wore off so quickly that newsprint could be read in about eight hours.

AUTHOR'S PROCEDURE

The subjects for this investigation were the students and faculty members of the University of Chicago, an exceedingly cooperative and highly intelligent group of patients. These persons came to the ophthalmic clinic complaining of symptoms in general referable to excessive use of the eyes for near work or merely for a check-up. Patients with ocular pathologic processes other than refractive error were excluded from the study. In all cases the corrected vision in each eye was at least 1.2.

The methods of instillation of the cycloplegic solutions and of measurement of the range of accommodation and diameter of the pupil were the same in all cases. Before the solution was instilled the patient was requested to look down, and the lower lid was pulled slightly away from the globe and the upper lid lifted well up. One drop only of solution at room temperature was dropped onto the

18. Naito, I.: Ueber Kombinationswirkung von Atropin und Kokain am menschlichen Auge, Klin. Monatsbl. f. Augenh. **68**:153, 1922.

19. Myerson, A., and Thau, W.: Human Autonomic Pharmacology: IX. Effect of Cholinergic and Adrenergic Drugs on the Eye, Arch. Ophth. **18**:78 (July) 1937.

20. Beach, S. J., and McAdams, W. R.: (*a*) Benzedrine in Refraction: Preliminary Report, Tr. Am. Ophth. Soc. **35**:221, 1937; (*b*) Benzedrine in Cycloplegia: II. Further Report, Tr. Am. Acad. Ophth. **42**:179, 1937.

21. Rutherford, C. T., in discussion on Beach and McAdams.[20b]

22. Powell, L. S.: Practical Use of Homatropin-Benzedrine Cycloplegia, Tr. Am. Acad. Ophth. **43**:264, 1938.

23. Berens, C., in discussion on Beach and McAdams.[20b]

24. Sudranski, H. F.: An Evaluation of Homatropine-Benzedrine Cycloplegia, Arch. Ophth. **20**:585 (Oct.) 1938.

25. Abbot, W. O., and Henry, C.: Paredrine: A Clinical Investigation of a Sympathomimetic Drug, Am. J. M. Sc. **193**:661, 1937.

26. Tassman, I.: The Use of Paredrine in Cycloplegia, Am. J. Ophth. **21**: 1019, 1938.

eyeball above the limbus and allowed to roll down over the cornea. The regions of the punctae were held tight for at least one minute by the clock.

The diameter of the pupil was measured to the nearest 0.5 mm. by a Schlösser tangent pupillometer, the eyes fixing an object approximately 25 feet (7.6 meters) distant.

A Prince's rule with a small sliding test card holder was most convenient for measuring the range of accommodation. The test print was a 6 point B8. In the trial frame before the eye to be measured was placed a spherical lens which might well roughly approximate the patient's refraction plus a 3 diopter lens. For example, before a 2 D. hyperopic eye a + 5 D. lens was placed, while before a 4 D. myopic eye a —1 D. lens was placed. The subject was then coached to signal as soon as he could no longer differentiate the B8. Immediately, each found the near point easily detected but was somewhat uncertain about the far point. However, after a few practice trials, the patient became surprisingly consistent about even the far point. The near and far points were read off the rule to the nearest 0.5 cm., transposed into diopters and the range of accommodation determined. All instillations and measurements were made by me.

ATROPINE SULFATE

Results with a Total of Ten Drops.—The average age of the patients in the group given 10 drops of a 1 per cent solution of atropine sulfate was 22.5 years. The age distribution is shown in chart 1. The age range was between 15 and 40 years. In determining the distribution of refractive error (chart 2), the spherical equivalent of the spherocylinder combination was used. The strongest cylinder in the series was only 2.25 D. In each of these cases the measurements were made, and atropine was instilled at 8 a. m., noon and 4 p. m. for three days. On the morning of the fourth day the last drop was instilled (making a total of 10 drops), the refraction was done and the measurements were made again. All the patients then returned for measurements each day for two weeks and most of them returned daily thereafter.

Cycloplegic Effect (chart 3): After the instillation of the first drop of atropine sulfate, the range of accommodation was found decreased after five minutes; it fell sharply in the next thirty minutes and then more slowly. This slow decrease continued until after the fourth drop, when the full effect had been attained. Further atropinization merely maintained the cycloplegia at 1.9 D. range of accommodation. After the last instillation the accommodative power fairly rapidly returned, so that by the third day the average patient could read newsprint. A few read by the second day and a few not until the fourth day. After the thirteenth day a slight drop in the range was observed with a gradual rise, so that by the eighteenth day slightly greater than starting range was found, an advantage soon lost. The variations from the average of 1.9 D. minimum range of accommodation are shown in chart 4. In this large series 70 per cent of the eyes were within 0.5 D. more or less

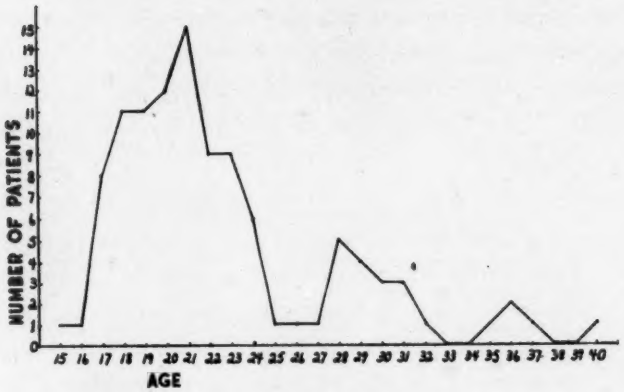


Chart 1.—Age distribution of 107 patients in the series given a total of 10 drops of atropine sulfate.

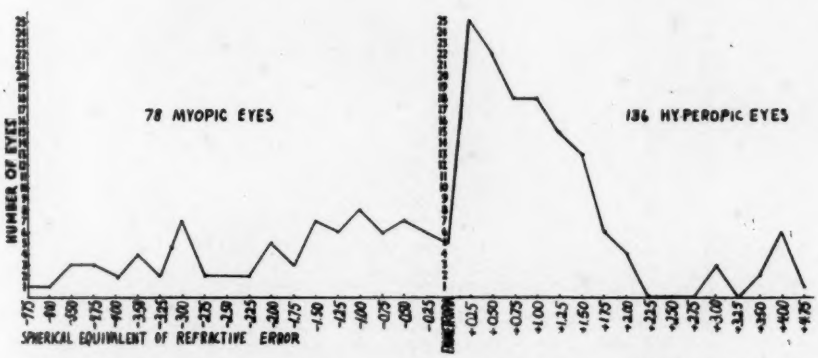


Chart 2.—Distribution of errors of refraction in the series of 214 eyes (78 myopic and 136 hyperopic eyes) in which a total of 10 drops of a 1 per cent solution of atropine sulfate was instilled.

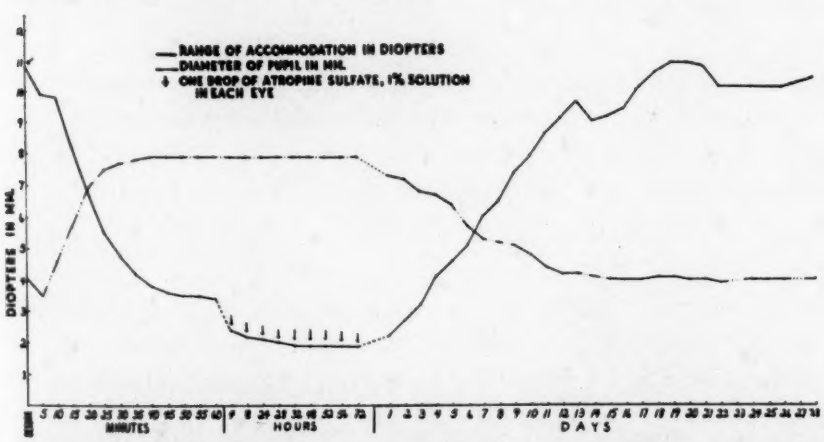


Chart 3.—Effect of a total of 10 drops of a 1 per cent solution of atropine sulfate on the range of accommodation and mydriasis of the 214 eyes.

of the 1.9 average. In no case was the variation more than 1 D. Each individual subject had reached his low level of range of accommodation at the thirty-second or forty-eighth hour reading, and this level, whether it was 2.7 D., 1.5 D. or as the case may be, was maintained until cessation of drops.

Mydriatic Effect (chart 3): Five minutes after the atropine was placed in the eye an average decrease of 0.6 mm in the pupillary diameter was found. This initial constriction was found in all the eyes in this series to amount to 0.5 mm. in most cases and 1 mm. in the remainder. The pupil dilated so that by forty minutes there was a maximum average diameter of 7.9 mm. This was maintained throughout atropinization.

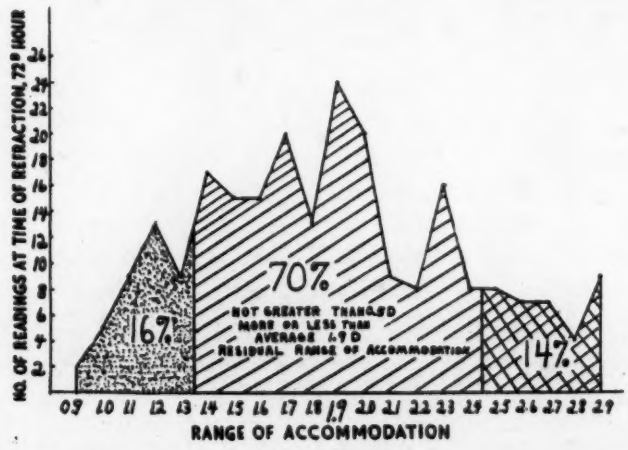

NO. OF READINGS AT TIME OF REFRACTION, 72ND HOUR
16%
70%
NOT GREATER THAN OR MORE OR LESS THAN AVERAGE 1.9 D
RESIDUAL RANGE OF ACCOMMODATION
14%
RANGE OF ACCOMMODATION

Chart 4.—Variations from the average minimum range of accommodation of 1.9 D. at the time of refraction in the series of 214 eyes in which 10 drops of atropine sulfate was instilled.

However, in 16 eyes after 6 or 7 drops the pupil was found to have decreased by 0.5 mm. in diameter. In general, four to six days after the last drop the pupils reacted to light, and the original pupillary diameter was observed by the twelfth day.

Results with a Total of Sixteen Drops (chart 5).—In order to discover if more prolonged atropinization than 10 drops in three days would give greater cycloplegia, 13 patients were given atropine three times daily for five days and the refraction was done on the sixth day after a total of 16 drops of a 1 per cent solution of atropine sulfate had been given. The age range of this group was 18 to 31, with an average age of 22.2 years. Reference to the graph on chart 5 will show

that in this smaller group after the sixth drop the range of accommodation did not change appreciably. The range at refraction was also 1.9 D. These patients required an average of three and a half days after the last drop to read newsprint. The initial pupillary constriction was found here also in all cases.

SCOPOLAMINE HYDROBROMIDE

The average age of the 21 patients used for the experiment with scopolamine hydrobromide (0.5 per cent solution) was 23.3 years, the ages ranging from 15 years to 37 years (chart 6). The drug is very powerful and fast acting, and with its use the range of accommoda-

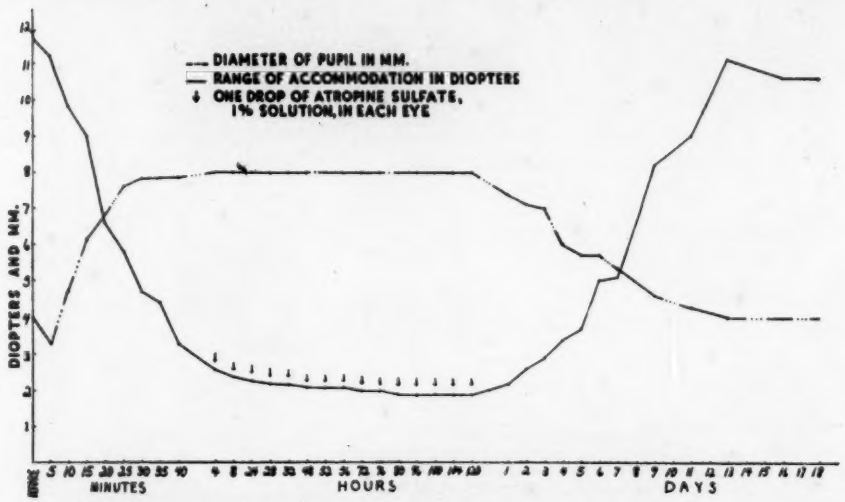


Chart 5.—Effect of a total of 16 drops of a 1 per cent solution of atropine sulfate on the range of accommodation and mydriasis of 26 eyes.

tion diminished quickly, so that the maximum effect was obtained in forty minutes to a low of 1.6 D., which persisted for at least ninety minutes. The accommodative power gradually returned, so that by the third day, when the range was again 3.3 D., the average patient could read. The normal range of accommodation was present by the tenth day.

With scopolamine also there was an early constriction of the pupil observed in all but 2 patients. Full mydriasis of 8 mm. average diameter was produced in twenty minutes; this lasted at least ninety minutes, and was normal by the eighth day.

HOMATROPINE-PAREDRINE COMBINATION

A 5 per cent solution of homatropine hydrobromide was instilled into the eyes of 25 patients; five minutes later a 1 per cent solution of

paredrine [27] was instilled, and five minutes later a 5 per cent solution of homatropine hydrobromide, 1 drop only each time (chart 7). The age range in this group was 17 to 57 years, with an average age of 28 years. The moderate conjunctival congestion and smarting caused by the homatropine were promptly relieved by the paredrine.

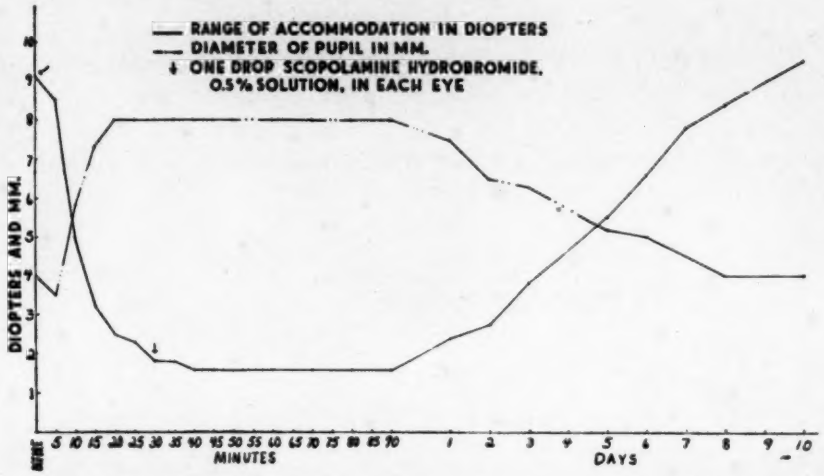

RANGE OF ACCOMMODATION IN DIOPTERS
DIAMETER OF PUPIL IN MM.
ONE DROP SCOPOLAMINE HYDROBROMIDE, 0.5% SOLUTION, IN EACH EYE
DIOPTERS AND MM.
MINUTES
DAYS

Chart 6.—Effect of a 0.5 per cent solution of scopolamine hydrobromide on range of accommodation and mydriasis of 42 eyes.

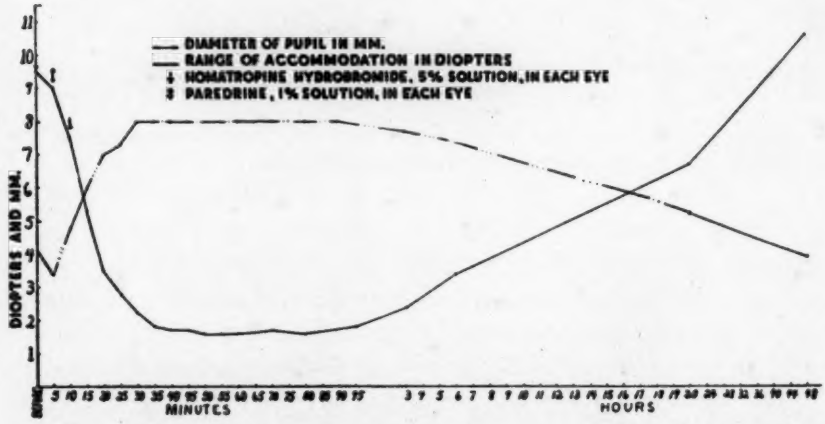

DIAMETER OF PUPIL IN MM.
RANGE OF ACCOMMODATION IN DIOPTERS
HOMATROPINE HYDROBROMIDE, 5% SOLUTION, IN EACH EYE
PAREDRINE, 1% SOLUTION, IN EACH EYE
DIOPTERS AND MM.
MINUTES
HOURS

Chart 7.—Effect of the homatropine-paredrine combination on the range of accommodation and mydriasis of 50 eyes.

After the first drop the range of accommodation rapidly decreased, so that the full effect was reached after fifty minutes. The range of

27. Supplied by Smith, Kline and French.

1.6 D. was maintained thirty minutes longer, after which a smooth return of accommodative power began, so that after three hours the range was 2.4 D., and after six hours, when the range was 3.4 D., the patient could read. Normal accommodation was present at forty-eight hours.

After the usual early constriction, the pupil dilated to a maximum diameter of 8 mm. in thirty minutes, where it remained fixed for another hour. A normal pupillary diameter was found in forty-eight hours.

TABLE 1.—*Comparison of the Results of the Cycloplegic Effect*

Drug	Time of Maximum Cyclo-plegia	Duration of Maximum Cyclo-plegia	Time at Which Patient First Reads	Accom-modation Normal	Range at Time of Refraction
Atropine sulfate 1% solution, 10 drops.....	32 hr.	8-24 hr.	3 days	18 days	1.9 D.
Atropine sulfate 1% solution, 16 drops.....	32 hr.	16-24 hr.	3½ days	18 days	1.9 D.
Scopolamine hydrobromide 0.5% solution.	40 min.	90 min. at least	3 days	8 days	1.6 D.
Homatropine-paredrine.....	50 min.	30 min.	6 hr.	36 hr.	1.6 D.

TABLE 2.—*Comparison of the Results Found on the Mydriatic Effect*

Drug	Full Mydriasis	Duration of Full Mydriasis	Greatest Diameter	Time When Normal Diameter Appears	No. of Eyes in Series
Atropine sulfate 1% solution, 10 drops.....	40 min.	8 hr.	7.9 mm.	12 days	214
Atropine sulfate 1% solution, 16 drops.....	40 min.	8 hr.	7.9 mm.	13 days	26
Scopolamine hydrobromide 0.5% solution.	20 min.	8 hr.	8 mm.	8 days	42
Homatropine-paredrine.....	30 min.	95 min.	8 mm.	48 hr.	50

SUMMARY AND CONCLUSIONS

Instillations of a 1 per cent solution of atropine sulfate gave maximum diminution of the range of accommodation after 4 drops. Further instillation merely maintained the average range of 1.9 D. The accommodative power gradually recovered so that most patients could read by the third day after the last drop and accommodation was normal by the eighteenth day. In all cases an initial constriction of the pupil occurred, possibly an irritative phenomenon. Full dilatation, averaging 7.9 mm. in diameter, occurred after forty minutes and was maintained in nearly all cases throughout atropinization. A normal diameter was found twelve days after the last drop.

Scopolamine is fast acting, so that forty minutes after the first instillation a minimum range of accommodation of 1.6 D. was found,

which lasted at least another fifty minutes. Recovery took place, so that by the third day the patient could read with a range of 3.3 D., and a normal range was present by the tenth day. Full mydriasis of 8 mm. was obtained after twenty minutes with recovery to normal by the eighth day.

A homatropine-paredrine combination used as described here resulted in a minimum range of 1.6 D. in fifty minutes, maintained for another thirty minutes. Recovery ensued, so that by the sixth hour with a range of accommodation of 3.4 D. the average patient could read newsprint. Normal range was found after forty-eight hours. Maximum dilatation of the pupil to 8 mm. diameter occurred within thirty minutes. Dilatation lasted ninety minutes, and the pupil was back to normal in forty-eight hours.

EXPERIMENTAL STUDIES OF OCULAR TUBERCULOSIS

IV. THE RELATION OF OCULAR SENSITIVITY, CUTANEOUS SENSITIVITY AND OCULAR ACTIVITY IN THE IMMUNE-ALLERGIC RABBIT

ALAN C. WOODS, M.D.

EARL L. BURKY, M.D.

AND

JONAS S. FRIEDENWALD, M.D.

BALTIMORE

In previous communications the general problem of ocular tuberculosis was discussed [1] and experiments were reported [2] on the interrelation of ocular sensitivity, ocular activity and cutaneous sensitivity in normal rabbits inoculated with tubercle bacilli either systemically or in the eye.

In the first paper [2a] on experimental work it was pointed out that the undiseased eyes of rabbits systemically infected with tubercle bacilli participated in the general sensitivity to tuberculoprotein, or tuberculin, manifested by the other tissues of the body and that, with minor fluctuations, the ocular and the cutaneous sensitivity were fairly parallel.

In the second report [2b] it was noted that when the eyes of normal rabbits were infected by the injection of tubercle bacilli, ocular sensitivity to tuberculoprotein became apparent at the end of the second week and was maximal by the third week. The first reaction of the eyes was a slowly progressive tuberculosis with hard tubercles. As the infection progressed, the eyes became hypersensitive to tuberculoprotein

---

From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

Part of the material in this paper and in paper V was presented before the Section on Ophthalmology at the Ninetieth Annual Session of the American Medical Association, St. Louis, May 18, 1939. The discussion was published with the proceedings in the December issue of the ARCHIVES, page 1130.

1. Woods, A. C.: The Problem of Ocular Tuberculosis, Am. J. Ophth. **21**: 366, 1938.

2. Woods, A. C.; Burky, E. L., and Friedenwald, J. S.: (*a*) Experimental Studies of Ocular Tuberculosis: I. Relation of Ocular Sensitivity to Cutaneous Sensitivity in the Systemically Infected Rabbit, Arch. Ophth. **19**:229 (Feb.) 1938; (*b*) II. The Relation of Ocular Activity to Ocular Sensitivity in the Normal Rabbit Infected by Injection of Tubercle Bacilli into the Anterior Chamber, ibid. **19**:236 (Feb.) 1938; (*c*) III. Relation of Cutaneous Sensitivity to Ocular Sensitivity in the Normal Rabbit Infected by Injection of Tubercle Bacilli into the Anterior Chamber, ibid. **19**:245 (Feb.) 1938.

and the inflammatory process became acute and was accompanied by caseation and necrosis. This acute inflammatory phase and the ocular sensitivity subsided synchronously, and thereafter healing of the ocular lesions occurred.

In the third paper [2c] it was reported that the injection of tubercle bacilli in the eyes of normal rabbits resulted in only a low degree of cutaneous sensitivity, although it produced a high degree of ocular sensitivity. There was no relation between the cutaneous and the ocular sensitivity in such animals, and the determination of cutaneous sensitivity gave no idea of the ocular sensitivity. The ocular sensitivity was apparently governed by the inflammatory process within the scleral envelop.

The experiments which are subsequently reported in the present paper are an extension of these studies to immune-allergic rabbits. Immune-allergic is a term applied to animals which have had a previous tuberculous infection, from which there has resulted both hypersensitivity to tuberculoprotein, or tuberculin, and more or less resistance or immunity to reinfection. The rabbits used in the experiments here reported were made immune-allergic by the injection into the groin of a living culture of virulent human tubercle bacillus. This injection produces a self-limited disease, from which the rabbit recovers in about three months, the animal being left with a well developed hypersensitivity to tuberculin and a relatively high immunity to reinfection, it requiring infection with a virulent bovine strain or a large dose of human bacilli to produce further tuberculous lesions.

The estimations of tuberculous activity in the eyes and the determination of both ocular and cutaneous sensitivity were made on two different series of immune-allergic rabbits, inoculated at different times. The conditions of the two experiments were otherwise identical, except that the second series of rabbits was somewhat larger than the first series and therefore permitted more prolonged observation.

EXPERIMENTAL WORK

In general the same technic was used in these experiments as in the preceding experiments on normal animals. The same virulent human tubercle bacillus was used. All systemic inoculations were made with 0.25 cc. of a thick emulsion of the bacilli in salt solution. When immune-allergic rabbits were inoculated in the eye it was found that the dose of tubercle bacilli which produced a satisfactory ocular tuberculosis in the eyes of normal rabbits did not produce any disease in these animals. After some experimentation it was found that a dose almost fifty times as strong, 0.2 cc. of an emulsion containing approximately 250 bacilli to the oil immersion field, was the minimum injection that would produce a satisfactory ocular tuberculosis in the immune-allergic rabbits. This was the dose used in both experiments for ocular inoculation.

The cutaneous sensitivity was determined by the intracutaneous injection of 0.005 mg. of the purified protein derivative of the tubercle bacillus. The ocular

sensitivity was determined by noting first the degree of ocular activity present in the rabbits to be tested and then giving an intraocular injection of 0.01 mg. of purified protein derivative. Two days later these rabbits were reexamined and the degree of ocular activity again noted. The difference in the degree of inflammation noted before and after the injection of purified protein derivative was taken as the index of ocular sensitivity.

For experiment 1, 26 rabbits were given the systemic infection by injection in the groin on Sept. 15, 1937. The subsequent duration of the experiment was twelve weeks. For experiment 2, 26 rabbits were inoculated systemically on Jan. 15, 1938, and reinoculated in the eyes on May 10. The subsequent duration of this experiment was eighteen weeks.

Plan of the Experiment.—The rabbits were examined clinically each week, and the development and intensity of the ocular tuberculosis were noted. As in the previous experiments, this is referred to as ocular activity and was noted on a numerical scale. The cutaneous sensitivity of each rabbit was determined likewise at weekly intervals.

The ocular sensitivity was determined each week on 2 rabbits, selected at random. Each time the ocular sensitivity was determined on the sample pairs, a normal rabbit was given a like intraocular dose of purified protein derivative as a control. No reactions were ever observed in the normal controls to the intraocular injection of the purified protein derivative.

There are available therefore for analysis: (1) weekly estimations of cutaneous sensitivity of the surviving members of the entire group over the period of the experiment, and of the pairs of rabbits killed weekly; (2) estimations of the ocular sensitivity of the pairs of rabbits killed weekly (which gives, if the pairs of rabbits are fair representatives of the group, a curve illustrating the behavior of ocular sensitivity during the course of the experiment); (3) clinical estimations of the course of the ocular tuberculosis in a group which became steadily smaller as the experiment progressed, and (4) histologic preparations of the enucleated eyes for checking the clinical observations of sensitivity and activity.

Validity of Results.—Before discussing the pertinent relation existing between ocular activity, ocular sensitivity and cutaneous sensitivity, the first question to be answered is: Are the pairs of animals killed weekly, which so largely furnish the experimental data for ocular sensitivity, fair representatives of the entire group? This question can be answered by comparing the ocular inflammation and the cutaneous sensitivity of the pairs of animals killed weekly with the average ocular activity and cutaneous sensitivity of the entire group at that time. These comparisons are shown in charts 1, 2, 3 and 4, illustrating these facts in the two series of immune-allergic rabbits which are the material for this report. In chart 1, illustrating the ocular activity of the selected pairs and the average weekly activity of the entire group in experiment 1, the curves are approximately identical, except for a sharp variation occurring at the eleventh week. At this time only 6 rabbits remained, 1 of which showed a high degree of ocular inflammation, while the remaining 5 showed only a minimal

reaction. The killing of this 1 animal accounts for this variation in the curves. In chart 2, illustrating the same facts for experiment 2, the curves parallel each other closely throughout. Chart 3 illustrates the cutaneous sensitivity of the pairs of rabbits killed at weekly intervals and the average cutaneous sensitivity of the entire group in experiment 1. The cutaneous sensitivity of the rabbits used for this experiment fluctu-

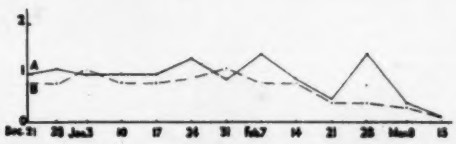


Chart 1 (experiment 1).—Average clinical ocular activity of the entire group of rabbits (*A*) and of the pairs treated at weekly intervals (*B*).

Chart 2 (experiment 2).—Average ocular activity of the entire group of rabbits (*A*) and of the pairs killed at weekly intervals (*B*).

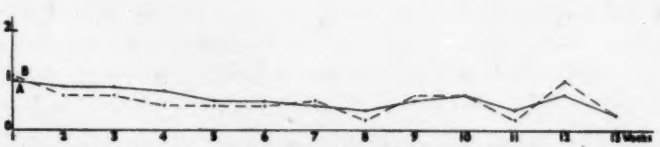


Chart 3 (experiment 1).—Average cutaneous sensitivity of the entire group of rabbits (*A*) and of the pairs killed at weekly intervals (*B*).

Chart 4 (experiment 2).—Average cutaneous sensitivity of the entire group of rabbits (*A*) and of the pairs killed at weekly intervals (*B*).

ated within a narrow range, but nevertheless the two curves closely approximate each other. Chart 4 shows similar curves for experiment 2. The curve illustrating the cutaneous sensitivity of the pairs of rabbits killed weekly again closely approximates the curve illustrating the average cutaneous sensitivity of the entire group.

It is apparent from the point of view of both ocular activity and cutaneous sensitivity that the pairs of rabbits killed weekly are fair samples of the entire group of rabbits used for each experiment. It is a fair assumption, therefore, that estimations of the ocular sensitivity made on the individual pairs of rabbits reflect the ocular sensitivity of the whole group. On this basis it appears justifiable to draw conclusions for the whole group from observations made on the selected pairs.

RESULTS

Course of the Ocular Tuberculosis.—After the inoculation of the suspension of tubercle bacilli in the right eyes of the immune-allergic rabbits there was a prompt inflammatory reaction, which reached its height in forty-eight hours and persisted for a period of four to nine days. This reaction was identical with that produced in the eye of immune-allergic animals by the injection of purified protein derivative and was clearly due to the presence of the tuberculin in the inoculum. The severity of this initial reaction closely paralleled the degree of cutaneous sensitivity manifested by the different rabbits. The immediate reaction faded, leaving the inoculated eyes either entirely quiet or with a low residual inflammatory reaction. About the second week after inoculation of the eye definite tuberculous inflammation appeared, with pericorneal injection, often slight haziness of the cornea with marginal vascular invasion and injection of the capillaries of the iris, followed by infiltration and thickening of the iris. This reached a rather low maximum, rarely over an estimated 2, about the fourth week. Multiple tubercles on the iris, with only a moderate attendant general inflammation, developed in approximately 50 per cent of these rabbits. The other 50 per cent showed a general iritis and keratitis, without visible tubercle formation. There was no evidence of caseation or necrosis, and perforation of the eyes never occurred. In these two series of rabbits the inflammatory reaction was distinctly less than that observed in the eyes of normal animals into which a much smaller dose was injected.

In the first series of immune-allergic rabbits this indolent keratouveitis persisted for about two months and then gradually subsided, leaving more or less scarred eyes. The eyes of the last 2 pairs of rabbits killed in this series were entirely quiet and inactive. In the second series the tuberculous inflammation reached its maximum about the fourth week, then showed a marked falling off from the fourth to the eighth week. Thereafter a second phase of active inflammation occurred, which persisted up to about the twelfth week. After that the entire group showed a gradual subsidence of the inflammation. At the

end of the sixteenth week the eyes of the 7 surviving rabbits were entirely quiet, without any evidence of inflammation or activity.

Ocular Sensitivity.—The ocular sensitivty was determined primarily from the clinical observations already described. In addition, after the clinical determinations were made the eyes were enucleated for histologic study. The histologic estimations were made by one of us (J. S. F.) without knowledge of the clinical findings.

It was extremely difficult, sometimes impossible, on microscopic study to differentiate the inflammatory reaction due to the tuberculous process from the inflammatory reaction due to the injection of purified protein derivative. However, in a number of eyes there were present fresh hemorrhages, obviously due to the reaction from the purified protein derivative. It was therefore possible in the main to follow the general course of the reaction in each experiment. The clinical estimations of ocular sensitivity and histologic estimations of acute allergic inflammation ran

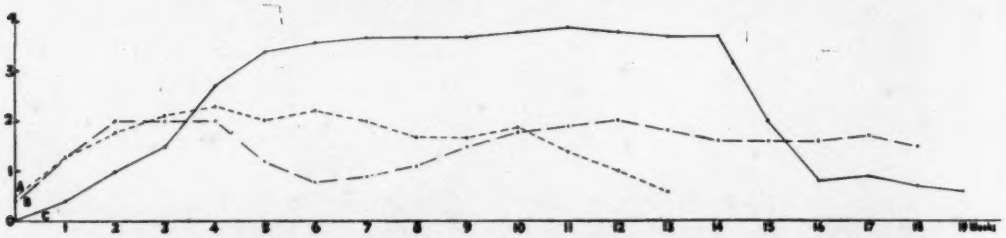


Chart 5.—Development and course of ocular sensitivity in normal and in immune-allergic rabbits after intraocular inoculation with tubercle bacilli. *A* is the curve for the rabbits in experiment 1; *B*, the curve for the rabbits in experiment 2, and *C*, the curve for the normal rabbits.

remarkably parallel. In the charts the ocular sensitivity is shown as the mean curve of the clinical and histologic readings.

Since the determination of the ocular sensitivity entails killing the experimental animal, no determinations were made in these experiments of the ocular sensitivity before the intraocular injections. Such determinations of ocular sensitivity resulting from the systemic infection were, however, made on similar rabbits inoculated systemically three months previously. These rabbits showed an average ocular sensitivity of 0.5. This figure may therefore be taken as indicative of the initial ocular sensitivity of immune-allergic rabbits prior to the secondary ocular inoculation and is therefore the beginning of the curve illustrating ocular sensitivity.

The curves of ocular sensitivity for these two series of immune-allergic rabbits are shown in chart 5, contrasted with the ocular sensitivity of normal rabbits after intraocular injection of tubercle bacilli.

In experiment 1 the ocular sensitivity rapidly increased for the first two weeks after inoculation and reached a maximum of a little over 2. It was maintained at approximately this level for a period of about seven weeks, after which it declined, but it was still definitely present at the end of the twelfth week, when the last pair of rabbits was killed. In experiment 2 the course of the ocular sensitivity, although it differed slightly, was somewhat similar. Again in the first two weeks of the experiment it reached its maximum of 2, was maintained at this level for approximately three weeks, then showed an unexplained decrease for several weeks, again increasing to a maximum of 2 by the twelfth week; thereafter it fell only slightly, being 1.5 at the end of the eighteenth week, when the tuberculous inflammation in the eyes was exhausted. However, after the eyes become quiet, the sensitivity probably continues to decline over the following weeks. This was shown by testing the ocular sensitivity of 5 similar rabbits in which the ocular tuberculosis had been quiet six weeks or more. These rabbits were tested at the end of the twenty-fourth week and showed an ocular sensitivity of only 0.5.

Chart 6 (experiment 1).—Relation of ocular sensitivity (*A*) to ocular activity (*B*) after intraocular injection of tubercle bacilli in immune-allergic rabbits.

As shown in chart 5, the behavior of ocular sensitivity in the normal and the immune-allergic rabbits after intraocular inoculation of tubercle bacilli is different. The normal rabbit showed a rapidly developing ocular sensitivity which continued to increase up to the fifth week, was maintained at a high level for fourteen weeks and then decreased rapidly as the tuberculous activity subsided, apparently being exhausted by the inflammatory process. The immune-allergic rabbits showed only a moderate increase in the ocular sensitivity for two weeks, and the maximum degree of sensitivity was decidedly less than that attained by normal rabbits. Likewise the spread of the bacilli throughout the eye was less in the immune-allergic animal. The development of local ocular sensitivity appears to be proportional to the dissemination and growth of the bacilli in the eye. When the immunity resulting from the former systemic inoculation is sufficient to restrain the growth and spread of the bacilli, then the development of ocular sensitivity is likewise restrained.

Relation of Ocular Sensitivity to Ocular Activity.—Chart 6 for experiment 1 and chart 7 for experiment 2 show the relation of ocular sensitivity to ocular activity. The initial transient inflammatory reaction after inoculation shown in these two charts was the reaction to the tuberculin in the inoculum. Thereafter, except for the concluding three weeks of observation, the ocular activity of the immune-allergic rabbits fairly well paralleled the degree of ocular sensitivity. Just as the eyes of the immune-allergic rabbits developed less sensitivity after inoculation with tubercle bacilli than did the eyes of normal rabbits, likewise the degree of tuberculous inflammation was decidedly less in the immune-allergic animals. In both experiments 1 and 2, toward the termination of the experiment the ocular activity became almost nil, the eyes becoming quiescent and free from clinical evidence of active inflammation.

Chart 7 (experiment 2).—Relation of ocular sensitivity (*A*) to ocular activity (*B*) after intraocular injection of tubercle bacilli in immune-allergic rabbits.

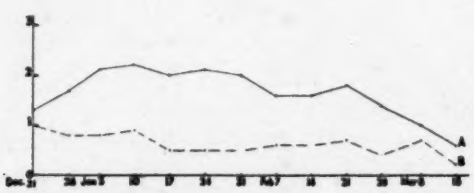


Chart 8 (experiment 1).—Relation of ocular sensitivity (*A*) and cutaneous sensitivity (*B*) after intraocular injection of tubercle bacilli in immune-allergic rabbits.

There still persisted, however, a moderate degree of ocular sensitivity. The observation on similar animals kept over a longer period indicates, however, that this persisting sensitivity gradually fails further. In the immune-allergic rabbits there appears to be a decided lag in the subsidence of ocular sensitivity after apparent healing of the eyes.

Relation of Ocular and Cutaneous Sensitivity.—It has already been noted that in both series of immune-allergic rabbits the ocular sensitivity rose slowly after inoculation of the eyes and, with a minor fluctuation in experiment 2, was maintained steadily during the period of observation. The cutaneous sensitivity behaved differently. In the first series of rabbits the cutaneous sensitivity declined steadily during the course of the experiment, the last 2 rabbits killed showing only a trace of reaction to the intracutaneous injection of purified protein derivative. In the

second series the cutaneous reactivity, relatively low at the beginning of the experiment, showed a sudden rise during a heat wave which occurred in the fifth week. Thereafter it dropped steadily, and at the end of the twelfth week the rabbits were all either totally insensitive to the intracutaneous injection of purified protein derivative or showed only the faintest trace of reaction. During this period the ocular sensitivity was relatively high.

The curves showing the relation of the ocular and cutaneous sensitivity in these two series of rabbits are shown in charts 8 and 9. It is apparent that under the conditions of this experiment the ocular and cutaneous sensitivity bear not the slightest relation to each other. The ocular sensitivity is apparently determined by the local process in the eye, and there is insufficient antigenic stimulus from a secondary ocular tuberculosis in the immune-allergic rabbit to influence or maintain the cutaneous sensitivity.

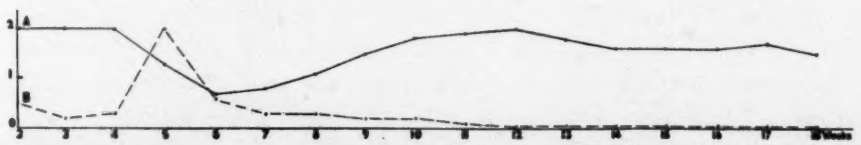


Chart 9 (experiment 2).—Relation of ocular sensitivity (*A*) and cutaneous sensitivity (*B*) after intraocular injection of tubercle bacilli in immune-allergic rabbits.

COMMENT

The immune-allergic rabbits used for this series of experiments showed as close an approximation to human ocular tuberculosis as seems possible to produce experimentally. With the assumption, as is generally believed, that ocular tuberculosis occurs in persons with a previous tuberculous infection and is the result of tubercle bacilli from the blood stream lodging in the eye, the similarity and difference between human ocular tuberculosis and experimental ocular tuberculosis in the immune-allergic animals are evident. The human and the experimental ocular diseases are similar in that they occur in animals with a previous systemic infection, whether it is healed or active, and both are produced by bacilli secondarily introduced into the eye. The two processes differ. First, the process in the human being is spontaneous, while in the experimental disease the bacilli are deliberately introduced; second, there are probably great differences in the doses of the invading bacilli; third, in the human being the bacilli almost undoubtedly reach the uveal tract of the eye by way of the blood stream, while in the experimental animal the bacilli are introduced from without directly into the aqueous.

As regards the first point of difference, spontaneous ocular tuberculosis in experimental animals systemically infected is an ideal which there is scant hope of ever attaining. All adult human beings are probably at one time or another in their lives systemically infected with tuberculosis, and the incidence of ocular tuberculosis in the general population is extremely low. Granted spontaneous ocular tuberculosis might occur in systemically infected animals, the precentage affected would be so small that the limits of cage space would be an insurmountable obstacle to any detailed study.

As regards the second point, the question of dosage, all that can be said is that these immune-allergic animals were given the minimum dose necessary to produce a smooth, progressive ocular tuberculosis. If bovine bacilli are used, even in much weaker doses, the ocular process is too violent and the animals succumb to a generalized infection.

As regards the third point, the portal of entry of the bacilli, all efforts in our hands to produce even a moderately constant ocular tuberculosis by intracarotid injection of the bacilli in immune-allergic rabbits have been unsuccessful. If weak suspensions of human bacilli are given, infection of the eyes does not follow, the immunity present being too great. If heavier suspensions are given, the rabbits usually die with symptoms of cerebral emboli. If bovine bacilli, which are highly virulent for rabbits, are given even in weak suspensions, the incidence of resulting ocular tuberculosis is low, and the incidence of disseminated tuberculosis with rapid death of the experimental animal is very high.

At the present time, therefore, there appears to be no closer approximation of human ocular tuberculosis possible. And in the main, when the dosage and virulence of the infecting organisms are properly controlled, the ocular tuberculosis in these immune-allergic animals closely approximates the disease as observed clinically in human beings. A large number of the rabbits show an ordinary iritis with secondary keratitis, characterized by the usual picture of inflammation of the iris, steaminess and infiltration of the cornea and vascularization from both the superficial and the deep vessels. The remainder, almost 50 per cent, show multiple hard tubercles studded over the iris, with a mild general iridic inflammation, and occasional tubercles in the cornea. If immune-allergic rabbits are given much larger doses of bacilli, caseating and necrotizing lesions may be produced, with later rupture of the globe—a picture identical with that occasionally observed in juvenile human ocular tuberculosis.[3] It seems possible, therefore, that the observation of these immune-allergic rabbits may shed some light on the fundamental problems of human ocular tuberculosis.

What do these experiments, as far as they have progressed, show? Primarily they give interesting information on ocular and cutaneous

3. Unpublished data.

sensitivity and the relation of the inflammatory reaction to ocular sensitivity. They clearly indicate that in immune-allergic rabbits with secondary ocular tuberculosis the further development and increase of ocular sensitivity are proportional to the growth of the bacilli within the eye and the local spread of the lesion, while the cutaneous sensitivity is unaffected to any degree by an active ocular tuberculosis. Apparently the local process within the scleral envelop does not provide sufficient antigenic stimulus to affect the cutaneous reactivity to purified protein derivative. There is no relation of any kind between the ocular and the cutaneous sensitivity of these animals. This finding is in line with the findings in normal rabbits and also with clinical observations. In a study of cutaneous reactivity of 180 patients with clinically diagnosed ocular tuberculosis, Woods and Randolph [4] found that 53.4 per cent showed high cutaneous sensitivity to tuberculin, 41.6 per cent showed only a moderate cutaneous reactivity, while 5 per cent was almost totally insensitive. In histologically proved ocular tuberculosis, Friedenwald and Dessoff found 20 per cent of the patients were cutaneously nonreactive to tuberculin. The findings in these experiments give experimental support for these clinical observations.

The relation between ocular sensitivity and ocular activity found in these immune-allergic rabbits is somewhat different from that found in normal rabbits. In the normal rabbit inoculated in the eye with tubercle bacilli, ocular sensitivity and ocular activity rapidly increased together to a high level, and healing of the tuberculous lesions and subsidence of ocular sensitivity occurred synchronously. In the immune-allergic rabbits, the ocular sensitivity increased as the tuberculous process became established in the eye, but it never attained the high level reached in the normal rabbit. After increasing to a low maximum, sensitivity and activity ran fairly well parallel until the latter part of the experiments, when the eyes healed, although a fair degree of ocular sensitivity remained. Thereafter ocular sensitivity gradually declined. There was an obvious lag in the subsidence of ocular sensitivity in immune-allergic animals after apparent quieting of the tuberculous inflammation. This brings up the question of factors other than the sensitivity which may influence the healing of the local ocular lesion. Further investigations are necessary on the influence of sensitivity and immunity on the course and healing of the local ocular lesion.

SUMMARY AND CONCLUSIONS

A study of the ocular inflammation, ocular sensitivity and cutaneous sensitivity of immune-allergic rabbits secondarily infected in one eye with tubercle bacilli permits the following conclusions:

4. Woods, A. C., and Randolph, M. E.: The Treatment of Ocular Tuberculosis, Arch. Ophth. **18**:510 (Oct.) 1937.

1. The dose of bacilli required to produce satisfactory ocular tuberculosis is much greater for the immune-allergic rabbit than for the normal rabbit. The growth of the bacilli and the spread of the lesion in the immune-allergic rabbit are distinctly restrained as compared with the progress in the normal rabbit similarly inoculated in the eye with a smaller dose of bacilli.

2. The development and increase of ocular sensitivity appear to be dependent on the actual growth of tubercle bacilli in the eye and the local spread of the tuberculous lesion and are less in the immune-allergic rabbit than in the normal rabbit.

3. Cutaneous reactivity to purified protein derivative is almost entirely uninfluenced by an active ocular tuberculosis, and the determination of the cutaneous sensitivity gives no indication of the degree of ocular sensitivity.

4. In the early stages of the ocular tuberculosis, the tuberculous inflammation roughly parallels the degree of ocular sensitivity. In the later stages of healing and repair this does not hold true. The tuberculous inflammation may quiet while a fair degree of ocular sensitivity remains. Thereafter ocular sensitivity declines, but there may be a definite lag in the subsidence of ocular sensitivity after apparent healing.

EXPERIMENTAL STUDIES OF OCULAR TUBERCULOSIS

V. THE QUESTION OF ORGANOTROPISM, OR THE SELECTIVE SENSITIZATION OF THE SECOND EYE

ALAN C. WOODS, M.D.
AND
EARL L. BURKY, M.D.
BALTIMORE

In the third experiment of this series [1] it was noted that when tubercle bacilli were injected into one eye of a normal rabbit the other eye appeared to show a somewhat greater reactivity to purified protein derivative than was manifested by the skin. This introduced the question of organotropism, or selective sensitization of the second eye, a point discussed by many other authors, especially with reference to sympathetic ophthalmia and the frequent bilateral occurrence of clinical ocular tuberculosis.

The previous experiment, in which such a selective sensitivity seemed a possibility, was conducted with normal rabbits under highly artificial conditions; the only tuberculous focus was in the eye, and it resulted from direct inoculation of the anterior chamber with tubercle bacilli. The only indication of selective sensitization of the second eye was found by the comparison of the reactivity to purified protein derivative of the eye and the skin, two utterly different tissues. It seemed desirable, therefore, to investigate this question further under conditions more closely approximating those found in clinical ocular tuberculosis. To this end the following experiment was undertaken.

EXPERIMENTAL WORK

Plan of Experiment.—On July 25, 1938, 56 normal rabbits were tested for hypersensitivity to tuberculin by the intracutaneous injection of 0.005 mg. of puri-

From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

Part of the material in this paper and in paper IV was presented before the Section on Ophthalmology at the Ninetieth Annual Session of the American Medical Association, St. Louis, May 18, 1939. The discussion was published with the proceedings in the December issue of the ARCHIVES, page 1130.

1. Woods, A. C.; Burky, E. L., and Friedenwald, J. S.: Experimental Studies of Ocular Tuberculosis: III. Relation of Cutaneous Sensitivity to Ocular Sensitivity in the Normal Rabbit Infected by Injection of Tubercle Bacilli into the Anterior Chamber, Arch. Ophth. **19**:245 (Feb.) 1938.

fied protein derivative of tuberculin.[2] The rabbits, as would be expected, all gave negative reactions. On July 27 they were given an injection of 0.25 cc. of a suspension of living human tubercle bacilli in the right groin. The same virulent strain used in previous experiments was employed, and the dose was the same used in previous experiments to prepare immune-allergic rabbits.[3] On November 7, the rabbits were divided into two equal groups, A and B. Group A was then inoculated in the anterior chamber of the left eye with 0.2 cc. of the undiluted paper filtrate of a six week old culture of the same tubercle bacillus. This was the same dose used in previous experiments on immune-allergic rabbits and was the minimum dose capable of producing a smooth, even ocular tuberculosis. The animals in group B were given identical inoculations in the left groin. There were therefore available for study two groups of immune-allergic rabbits, group A with a secondary unilateral ocular tuberculosis and group B with a secondary inoculation in the groin. In both series the secondary antigenic stimuli given in the eye and the groin were identical.

Beginning one week after the secondary injection and at weekly intervals thereafter, 2 animals of each group were tested for ocular sensitivity in both eyes. The technic used was that previously employed. The eyes were first examined clinically, and any activity present (which existed only in group A in the eyes in which injection was made) was noted. An injection of 0.01 mg. of purified protein derivative was made into the anterior chamber of each eye of the selected pairs of both groups, as described in the former papers. The eyes were then examined clinically at the end of forty-eight hours, and the degree of activity was noted. In the tuberculous left eyes of the rabbits of group A the difference between the readings before and after the injection of purified protein derivative was taken as the index of ocular sensitivity. The degree of inflammatory reaction in the normal right eyes of the rabbits of group A and in each eye of the rabbits of group B represented the reaction to purified protein derivative and was taken as the degree of ocular sensitivity in these eyes. As a control, a normal rabbit was given an injection of purified protein derivative in a like manner in both eyes. The cutaneous sensitivity in the selected pairs and in the entire group was determined each week by the intracutaneous injection of 0.005 mg. of purified protein derivative. After the determination of the ocular sensitivity in the selected pairs, the animals were killed.

There are therefore available for analysis figures giving the sensitivity of the tuberculous left eyes of the animals of group A at weekly intervals during the course of the experiment and also the sensitivity of the undiseased eyes. For comparison there are available figures on the ocular sensitivity of the rabbits of group B at similar intervals during the course of the experiment and also weekly estimations of the cutaneous sensitivity of both groups of rabbits.

It may be emphasized here that the ocular sensitivity represents the reaction of the eye to twice the dose used to evoke the cutaneous reaction and to estimate cutaneous sensitivity.

---

2. Seibert, F. B.: Chemical Composition of the Active Principle of Tuberculin, J. Infect. Dis. **51**:383, 1932; Relationship Between the Sensitizing Properties of Tuberculo-Protein and Its Molecular Weight, Tr. Nat. Tuberc. A. **29**: 165, 1933.

3. Woods, A. C.; Burky, E. L., and Friedenwald, J. S.: Experimental Studies of Ocular Tuberculosis: IV. The Relation of Ocular Sensitivity, Cutaneous Sensitivity and Ocular Activity in the Immune-Allergic Rabbit, Arch. Ophth., this issue, p. 351.

Validity of Results.—Before any comparison of the results for group A and group B can be made, a question must be answered, as in previous experiments, Are the pairs selected at random at weekly intervals, with which the actual comparisons are made, fair samples of the entire group? This can be determined for group A by comparing the ocular activity of the tuberculous eyes of the selected pairs with the average ocular activity of the entire group at the time the pairs were killed, and for both groups A and B by comparing the cutaneous activity of the selected pairs with the average cutaneous activity of the entire groups at the time the selected pairs were killed. This comparison was made as in former experiments, and as before the curves were everywhere practically identical. For the sake of brevity, they are not reproduced here. Suffice it to say, the selected pairs appear to be fair samples of the group, and conclusions based on observations of such rabbits appear justifiable.

Course of Ocular Tuberculosis in Rabbits of Group A.—The course of the ocular tuberculosis in the rabbits of group A was essentially the same as reported in study IV,[8] in which immune-allergic rabbits received a similar injection of tubercle bacilli in the eye. There was an immediate inflammatory reaction to the tuberculin in the inoculum, which gradually subsided. About two weeks after inoculation a slow, non-caseating ocular tuberculosis began to develop in the eyes, hard tubercles over the iris developing in about 50 per cent while an ordinary progressive keratoiritis with little characteristic in the picture developed in the remainder. Toward the end of the experiment in January 1939, the activity was gradually subsiding. Ten rabbits given similar injections were held for further experimentation, and five and a half months later the eyes were entirely inactive.

Results as Concern Organotropism.—The fundamental question as concerns organotropism, or a selective sensitivity of the second eye of a rabbit with ocular tuberculosis, involves a comparison of the sensitivity of the right eyes of the rabbits of group A with the mean sensitivity of both eyes of the rabbits of group B. Phrasing it somewhat differently, did the antigenic stimulus from the tuberculous eye of the immune-allergic rabbit produce a greater sensitivity of the second eye than was produced in the eyes of similar rabbits by an identical inoculum of tubercle bacilli given systemically?

Chart 1 shows the sensitivity of the undiseased right eyes of the rabbits of group A compared with the mean sensitivity of the undiseased eyes of the rabbits of group B. It is immediately obvious, under the conditions of this experiment, that the tuberculous process in the left eyes of the rabbits of group A did not produce any selective sensitivity of the undiseased right eyes. The curves illustrating the sensitivity of the right eyes of the rabbits of group A and the mean of both eyes of the

rabbits of group B are essentially the same, fluctuating usually at a low level and interlacing irregularly throughout the duration of the experiment.

There are various points of secondary interest shown by these rabbits. Several of these points have already been discussed in a previous paper (study IV) and here merely confirm our previous results. These secondary points are: 1. Is there any difference in the sensitivity of the undiseased right eyes of the rabbits of group A and their cutaneous sensitivity? 2. Does the sensitivity of the diseased left eyes of the rabbits of group A bear any relation to the cutaneous sensitivity? 3. Is there any appreciable difference in the cutaneous sensitivity of the two groups, produced in the rabbits of group A by the combination of systemic and ocular inoculations and in those of group B by two systemic

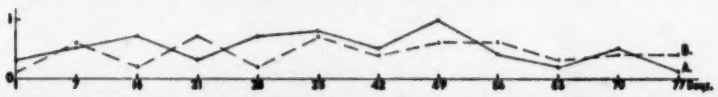


Chart 1.—Sensitivity of the undiseased right eyes of the rabbits of group A (immune-allergic rabbits with ocular tuberculosis) compared with the average ocular sensitivity of the undiseased eyes of the rabbits of group B (immune-allergic rabbits with second systemic inoculation). Curve *A* is for the rabbits of group A and curve *B* for those of group B.

Chart 2.—Ocular sensitivity of the undiseased eyes of the rabbits of group A compared with the cutaneous sensitivity. Curve *A* represents the ocular sensitivity and curve *B* the cutaneous sensitivity.

inoculations? 4. What is the relation of the ocular sensitivity and ocular activity of the diseased eye of the rabbits of group A?

Chart 2 shows a comparison of the sensitivity of the undiseased eyes and the cutaneous sensitivity of the rabbits of group A. In this group both the ocular and the cutaneous sensitivity resulted from the combination of the first systemic and the second ocular inoculation. Here again there is no essential difference in the sensitivity of these two radically different tissues to tuberculoprotein. The curves are essentially the same throughout, different as are the tissues, their type of reaction to the antigen and the dose of purified protein derivative producing the reaction. These curves also indicate that no selective sensitization of the undiseased eye has occurred.

Chart 3 shows the sensitivity of the diseased left eyes of the rabbits of group A compared with their cutaneous sensitivity. Here the picture is different and confirms exactly the results reported in a previous experiment. A local tuberculous process within the scleral envelop produces a

marked sensitivity of the diseased eye, while it has little or no influence on the cutaneous sensitivity. The significance of this observation has been discussed in other communications in this series.

Chart 4 shows a comparison of the cutaneous sensitivity of the rabbits of group A with that of the rabbits of group B. These curves are almost identical, fluctuating at a rather low level throughout the experiment. The sensitivity of the skin was essentially the same for the two groups, irrespective of whether the second stimulus arose in the eye or from an inoculation in the groin.

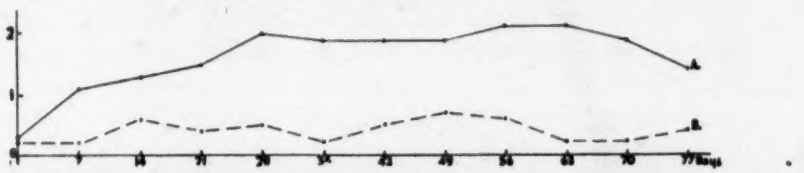


Chart 3.—Ocular sensitivity of the diseased left eyes of the rabbits of group A compared with the cutaneous sensitivity. Curve *A* represents the ocular sensitivity and curve *B* the cutaneous sensitivity.

Chart 4.—Cutaneous sensitivity of the rabbits of group A (curve *A*) compared with that of the rabbits of group B (curve *B*).

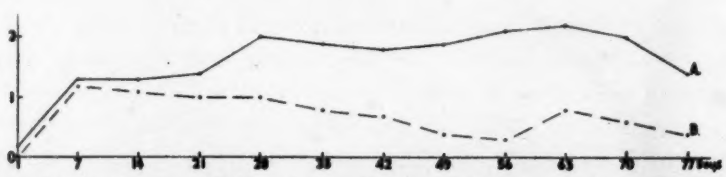


Chart 5.—Ocular sensitivity of the diseased left eyes of the rabbits of group A compared with the ocular activity. Curve *A* represents the ocular sensitivity and curve *B* the ocular activity.

Chart 5 shows finally the relation between the activity, or the degree of tuberculous inflammation in the left eye, and the development of sensitivity of the eye to tuberculoprotein. Here again the results confirm those reported in the preceding study of this series. The sensitivity increases slowly as the disease spreads and in the early stages increases proportionately. However, neither the spread of the lesion nor the development of sensitivity are nearly as marked as after a similar inoculation in the normal rabbit. In the latter stages of the experiment the activity declines while the sensitivity remains fairly constant. The significance of these observations has already been commented on and is the subject of further investigations.

COMMENT

In the experiments on normal rabbits [1] it was noted that inoculation of one eye with tubercle bacilli apparently was followed by an undue sensitivity of the second eye to tuberculoprotein, especially when compared with the resulting cutaneous sensitivity. Whether this was an actual selective sensitization or was due to the difficulty of comparing different types of reaction in different tissues was not clear. Certainly, when the experiment was repeated in immune-allergic rabbits this phenomenon was not noted. There are several possible explanations: 1. Selective sensitization is a myth, and with the exception of the diseased eye, in which the process is restrained by the resistant scleral envelope, the other tissues of the body react equally to the same antigenic stimulus. 2. The factor of immunity, which noticeably restrains the growth of the bacilli and the spread of the lesion, whether it is in the eye or in the groin, has so restrained the growth of the bacilli on the second inoculation that the resulting antigtnic stimulus is insufficient to influence the general reactivity to tuberculoprotein. In any event, the conclusion is the same. In the immune-allergic animal, under the conditions here studied, a tuberculous disease of one eye does not produce any selective sensitivity of the second eye. This observation is strengthened by the facts that throughout this experiment the sensitivity of the second eye parallels the cutaneous sensitivity and that the cutaneous sensitivity of the two groups of rabbits is the same, being uninfluenced by the site of the second inoculation, whether it is in the eye or in the groin.

If selective sensitization of the second eye is regarded as a myth, then some other explanation must be sought for the extremely frequent bilateral involvement of the eyes by tuberculosis. The simplest and most logical explanation would be to assume that in persons with ocular tuberculosis the eyes are constitutionally less resistant and unduly susceptible to tuberculous infection.

The marked sensitivity of the diseased eye developing after ocular inoculation and the relation between ocular activity and sensitivity confirm the results reported in the preceding paper of this series, which have already been commented on.

CONCLUSIONS

1. In immune-allergic rabbits under the experimental conditions here reported a tuberculous disease in an eye does not produce selective sensitization of the second eye.

2. The undiseased eye and the skin react in a similar and apparently equal manner to a secondary tuberculous focus in one eye.

3. The general reaction of an immune-allergic rabbit, as manifested both by the ocular and by the cutaneous sensitivity, is the same whether the second antigenic stimulus is in the eye or in the groin.

FAILURE OF GALACTOSE GIVEN SUBCUTANEOUSLY TO PRODUCE CATARACT IN RATS

RAYMOND M. SELLE, PH.D.
LOS ANGELES

The literature pertaining to the production of cataract in the eyes of mammals has been reviewed recently by Bourne.[1] A number of different chemicals are known to bring about a clouding of the lens when ingested by mammals, as when naphthalene is fed to rabbits and thallium acetate to rats. Likewise, ergot and dinitrophenol have been reported as being responsible for cataractous conditions in a number of human eyes. In 1935 Mitchell and Dodge[2] observed that mature bilateral cataract developed in rats fed a ration containing 70 per cent lactose for ten weeks. They found that lesser amounts of lactose resulted in a slower development or a less pronounced opacity of the lens.

Mitchell[3] then reported that it was the galactose fraction of the lactose molecule that was responsible for the changes in the lens and demonstrated that mature bilateral cataracts will develop in rats within twelve to thirty-seven days when fed diets containing 35 per cent galactose. This work was immediately confirmed by Yudkin and Arnold[4] and by Day.[5]

The exact manner by which the galactose induces the formation of the cataracts is not known. Bourne pointed out that there is no evidence to show whether the changes in the lens are the result of a general metabolic disturbance due to the ingestion of the galactose or whether the galactose directly damages the protoplasm in the lens.

With this in mind, it seemed desirable to study the effects of galactose when administered hypodermically. Twenty young adult female albino rats, averaging 160 Gm. in weight, were divided equally into two groups. The experimental animals were given each day subcutaneously 2 cc. of a 50 per cent solution of galactose (chemically pure) in a 0.85 per cent aqueous solution of sodium chloride. The galactose was dissolved with the aid of heat. The controls were given

From the Department of Biology, Occidental College.

1. Bourne, M. C.: Physiol. Rev. **17**:1-27, 1937.
2. Mitchell, H. S., and Dodge, W. M.: J. Nutrition **9**:37-48, 1935.
3. Mitchell, H. S.: Proc. Soc. Exper. Biol. & Med. **32**:971-973, 1935.
4. Yudkin, A. M., and Arnold, C. H.: Proc. Soc. Exper. Biol. & Med. **32**: 836-837, 1935.
5. Day, P. L.: J. Nutrition **12**:395, 1936.

2 cc. of the same salt solution without the galactose. Each animal received one hundred and twenty consecutive daily doses of the galactose or the plain salt solution. All of the females that were not pregnant or nursing young were kept in breeding cages with adult males.

The observable results were negative. Cataract did not develop in any of the rats so far as could be determined with an ophthalmoscope. During the experiment the 10 control female rats gave birth to 124 young in 19 litters (average, 6.5), and the 10 females that had received galactose had 106 young in 17 litters (average 6.1). All of the offspring were born with normal eyes, except that in both groups, control and experimental, a female gave birth to a litter of 2, and in both instances the young had defective eyes. (The young in the second litters of these 2 females were all normal.)

Of the 4 young born with defective eyes, 3 were females, and all of them had large bilateral cataracts. When sexually mature, the females were bred to the lone male, with the result that in the 3 litters produced (2, 3 and 6, respectively) every one of the offspring had normal lenses. Apparently the appearance of the cataracts in the second generation was not due to hereditary causes.

Since Mitchell and Cook [6] stated that cataracts develop most readily in young rats fed galactose and that adult animals show more resistance to lenticular changes due to a foreign sugar in the blood, an experiment with young rats was carried on for eighty days. Seventeen 21 day old rats were selected and given daily subcutaneous doses (1 cc.) of the 50 per cent solution of galactose. Cataract did not develop in any of the rats.

The conclusion is that cataract does not develop in rats when galactose is given subcutaneously.

---

6. Mitchell, H. S., and Cook, G. M.: Galactose Cataract in Rats: Factors Influencing Progressive and Regressive Changes, Arch. Ophth. **19**:22-33 (Jan.) 1938.

ROLE OF THE CERVICAL SYMPATHETIC NERVE IN THE LIGHT REFLEX OF THE PUPIL

E. A. SPIEGEL, M.D.
PHILADELPHIA
AND
N. P. SCALA, M.D.
WASHINGTON, D. C.

The Hering-Sherrington law of reciprocal inhibition of antagonists has been found valid not only in the innervation of striated muscles but in the innervation of some parts of the autonomic nervous system. Stimulation of the depressor nerve, for instance, reflexly decreases the tone of the vasoconstrictors and increases that of the vasodilators (Bayliss [1]); it also induces vagal inhibition and inhibits the accelerator nerves of the heart (Bruecke [2]). As to the pupil, it is known from animal experiments as well as from clinical experience (Bumke [3]) that dilatation of the pupil produced by painful stimuli or psychic excitation is brought about not only by stimulation of the dilator but by inhibition of its antagonist, the sphincter of the pupil. It seems, therefore, not unjustified to presume that reciprocal inhibition may also play a part in the mechanism of the light reflex. In fact, such opinions were expressed by Uriarte [4] and by Myerson and Thau.[5] Uriarte even considered dilatation of the pupil in the dark due to excitation of the cervical sympathetic nerve as the primary reaction; accordingly, he assumed that decrease of the excitation of this nerve induces relaxation of the dilator in the light. Myerson and Thau similarly assumed that the light reflex is made up of two important parts, dilatation of the pupil to dark and constriction to light, and that these movements are brought about by reciprocal activity of the sympathetic and parasympathetic systems.

The question whether the law of reciprocal innervation is valid for the light reflex is of interest not only from a physiologic but from a

---

From the Department of Experimental Neurology, D. J. McCarthy Foundation, Temple University, School of Medicine, Philadelphia.

1. Bayliss, W. M.: J. Physiol. **14**:317, 1893; **37**:264, 1908.
2. Bruecke, E.: Ztschr. f. Biol. **67**:507, 1917.
3. Bumke, O.: Pupillenstörungen, Jena, Gustav Fischer, 1911.
4. Buenafama Uriarte, A.: Ann. d'ocul. **172**:672, 1935.
5. Myerson, A., and Thau, W.: Human Autonomic Pharmacology: Effect of Benzedrine Sulfate on the Argyll Robertson Pupil, Arch. Neurol. & Psychiat. **39**:780 (April) 1938.

pathologic and clinical point of view, since Uriarte explained the Argyll Robertson pupil as due to paralysis of the dilator mechanism.

In view of these theories of Uriarte and of Myerson and of Thau's observation that instillation of benzedrine sulfate may at least partly restore the light reflex in patients with Argyll Robertson pupils, it seemed of interest first quantitatively to determine the effect of sympathectomy on the one hand and of benzedrine after sympathectomy on the other hand on the ability of the pupil to contract on illumination and to dilate in the dark, respectively. The results of such an experiment are illustrated in figure 1.

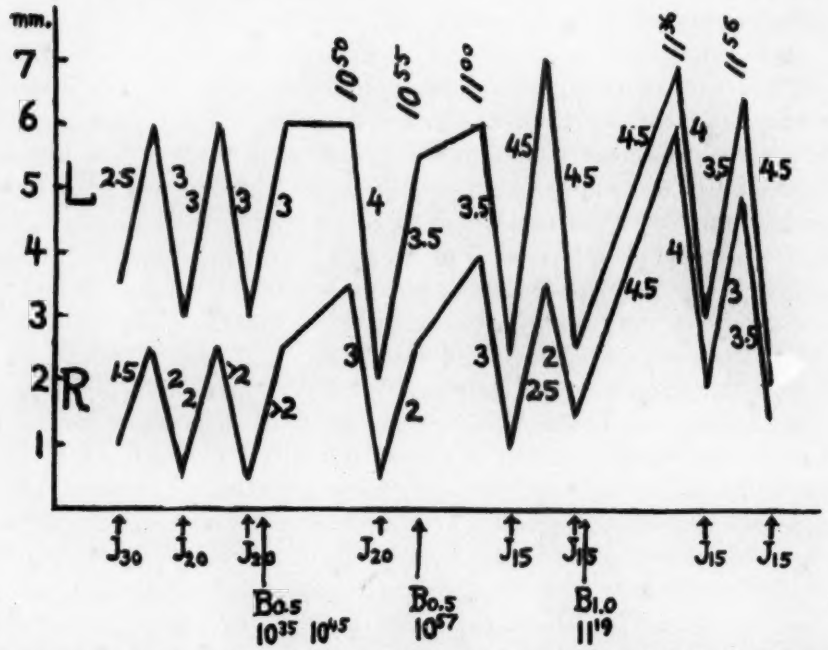


Fig. 1.—Pupillary diameter in millimeters of the right (*R*) and left (*L*) eye of a cat subjected to sympathectomy on the right side. The peaks of each curve indicate the diameters of the pupil in a semidark room; the bottoms indicate the diameters on illumination. The figures between the peaks and the bottoms indicate the difference between the values obtained in the light and those obtained in the dark. Illumination was done with a 75 watt lamp at distances of 30 (J_{30}), 20 (J_{20}) and 15 cm. (J_{15}), respectively. *B* 0.5 and *B* 1.0 indicate instillation of benzedrine sulfate, 0.5 per cent and 1 per cent solution, respectively, in the right conjunctival sac.

It seems unnecessary to emphasize the well known fact that the light reflex of the pupil is preserved after sympathectomy and that the diameter of the pupil is smaller on the sympathectomized side than on the normal side in the light and also in the dark. A quantitative measure of the ability of the pupil to dilate in the dark and to contract on illumina-

tion may be obtained by determining the difference between the values obtained in the light and those obtained in the dark. This difference is larger on the normal than on the sympathectomized side (fig. 1), indicating, in agreement with the infra-red photographs of Gullberg, Olmsted and Wagman,[6] that the dilatation in the dark is less complete when the cervical sympathetic nerve is cut.

Instillation of a 0.5 to 1 per cent solution of benzedrine sulfate in the conjunctival sac on the sympathectomized side increases the diameter of the pupil; this may be observed not only in the dark but on the illuminated eye. The dilatation is, however, more marked in the dark. As a result the ability of the pupil to dilate in the dark is increased, as shown by the increase of the difference between the values obtained in the light and those obtained in the dark, which difference may at least transitorily reach the same figure as on the normal side. Owing to absorption of the benzedrine, the diameter of the pupil eventually may increase in the dark on the normal side also.

The question presents itself whether the influence of the cervical sympathetic nerve on dilatation of the pupil in the dark is due to an increase of the impulses conducted by this nerve when the illumination of the retina ceases or whether the tonic innervation of the dilator muscle, remaining equal in the light and in the dark, suffices to enhance the effect of the relaxation of the sphincter muscle in the dark. In order to study this question, experiments with section of the oculomotor nerve were performed. An active contraction and relaxation of the dilator muscle should become manifested after section of the oculomotor nerve, particularly if a certain contraction of the pupil is restored by restitution of the tone of the sphincter muscle, e. g., by the instillation of physostigmine salicylate.

The following protocol may illustrate such an experiment.

April 13, 1939: A cat was employed for the experiment.

11:30 a. m.: The right oculomotor nerve was cut at the base of the brain.

2:30 p. m.: The right pupil measured 11 mm. in width and the left 2 mm. Illumination was done with a 300 watt lamp. There was abduction of the right eye but no reaction of the right pupil; the left pupil appeared slitlike.

3:15 to 3:20 p. m.: 3 × 3 drops of a 0.1 per cent solution of physostigmine salicylate was instilled in the right conjunctival sac.

3:30 p. m.: The right pupil still measured 11 mm. in width and failed to contract on illumination; the left pupil contracted from 3 mm. to a slit.

3:35 to 3:53 p. m.: 5 × 3 drops of a 0.2 per cent solution of physostigmine salicylate was instilled in the right conjunctival sac.

3:55 p. m.: The right pupil was 10 mm. wide and showed no light reflex; the left pupil contracted from 5 mm. to a slit.

6. Gullberg, J. E.; Olmsted, J. M. D., and Wagman, I. H.: Am. J. Physiol. **122**:160, 1938.

3:56 p. m.: 3 drops of a 0.2 per cent solution of physostigmine salicylate was instilled in the right conjunctival sac.

4:10 to 4:15 p. m. The right pupil measured 9 mm. and failed to contract on illumination.

4:26 p. m.: The right pupil measured 3 mm. and failed to contract on illumination.

4:30 p. m.: The right pupil measured 2 mm. and failed to contract on illumination.

These experiments show that after elimination of the innervation of the sphincter muscle there is no indication of a reaction of the dilator muscle to illumination or to darkness, even if a medium width of the pupil is restored by instillation of physostigmine salicylate. It may be inferred that the part played by the cervical sympathetic nerve in enhancing the dilatation of the pupil in the dark is not due to an increase of the impulses transmitted by this nerve in the dark but simply to the tonic innervation of the dilator, which is not influenced by changes of illumination of the retina. This conclusion is confirmed by a third series of experiments in which the electrical potentials of the cervical sympathetic nerve of cats were recorded, and it was studied whether the potentials of this nerve differ while the eyes are kept in the dark and on illumination of the retina.

In order to record the electrosympathicogram, the cervical sympathetic nerve (the intact nerve or the caudal end of the cut nerve) was placed on silver and silver chloride electrodes, connected with a Sanborn string galvanometer with a three stage amplifier (for details of the recording system see Spiegel[7]). The records were taken partly from animals in which superficial ether anesthesia had been induced and partly from curarized cats. Each animal and the recording apparatus were kept in a Faraday cage in order to prevent disturbances from extraneous currents. The eyes were illuminated by a 75 watt lamp standing outside the Faraday cage at a distance of 0.5 meter from the eyes. In order to insure the illumination of the retina, the lids were kept apart by an eye speculum, the nictitating membrane was excised and the pupils were dilated by instillation of atropine.

While the animal was kept in the dark, the electrogram of the cervical sympathetic nerve showed quick oscillations (up to 200 to 300 per second) similar to those described by Einthoven, Hoogerwerf, Karplus and Kreidl.[8]

With noncurarized animals illumination produced some deflections of the string of large amplitude. When the animals, however, were

7. Spiegel, E. A.: Labyrinth and Cortex: Electrencephalogram of the Cortex in Stimulation of the Labyrinth, Arch. Neurol. & Psychiat. **31**:469 (March) 1934.

8. Einthoven, W.; Hoogerwerf, S.; Karplus, I. P., and Kreidl, A.: Arch. f. d. ges. Physiol. **215**:443, 1927.

curarized, such large deflections no longer appeared, and a definite difference between the effect of dark and that of light could not be observed (fig. 2). Occasionally slow waves appeared at a rhythm of 3 per second. Such slow waves, however, were observed not only while the eyes were illuminated but while the animal was kept in the dark. An indication for differences of activity of the cervical sympathetic nerve in these two states could not be found.

The question whether the law of reciprocal innervation is valid for the light reflex of the pupil must be answered in the negative sense, since changes in the diameter of the pupil were not observed on illumination if only the sympathetic innervation was preserved and since the electric potentials led off from the cervical sympathetic nerve do not differ on illumination of the retina and in the dark. Thus Uriarte's theory of the Argyll Robertson pupil, which is based on the assumption of an active contraction of the dilator in the dark, is not tenable; this is also evident if one considers how slightly the light reflex is affected after section of the cervical sympathetic nerve. Consequently the pathologic mechanism of the Argyll Robertson pupil should be sought for

Fig. 2.—Electrosympathicogram of a curarized cat with leads from the caudal part of the cut left cervical sympathetic nerve. In *A* illumination of right eye was begun at the arrow. In *B* it ceased at the arrow. *C* shows standardization with 0.1 millivolt.

within the reflex arc inducing contraction of the pupil on illumination. As was pointed out in a previous paper (Spiegel and Scala [9]), a secondary contracture of the sphincter muscle may participate in the genesis of the Argyll Robertson pupil. The observation of Myerson and Thau [5] that instillation of benzedrine sulfate in the conjunctival sac may partially restore the light reflex in cases of Argyll Robertson pupil is perhaps due to the fact that in these cases only some fibers of the sphincter are in a state of contraction and that the increase of the dilator tonus produced by benzedrine counteracts this contracture, so that the dilatation of the pupil in the dark is facilitated, and those fibers of the sphincter which are still able to react on the reflex impulses from the retina are less impeded in their reaction by the contracted fibers.

9. Scala, N. P., and Spiegel, E. A.: Pupillary Reactions in Combined Lesions of the Posterior Commissure and of Pupillodilator Tracts: Contribution to the Pathogenesis of Argyll Robertson Pupil, Arch. Ophth. **15**:195 (Feb.) 1936.

SUMMARY

Section of the cervical sympathetic nerve slightly impairs the ability of the pupil to dilate in the dark; the difference between the width of the pupil in the dark and that in the light is smaller on the side which has been operated on than on the normal side.

Instillation of benzedrine sulfate into the conjunctival sac of an eye the dilator muscle of which is paralyzed by cervical sympathectomy may transitorily abolish this slight impairment of the pupil to dilate in the dark.

After section of the oculomotor nerve, changes in the diameter of the pupil in the light and in the dark could not be noticed, even when a medium width of the pupil was restored by instillation of physostigmine salicylate.

The electrosympathicogram of curarized cats was not changed either on illumination of the retina or on interruption of the illumination.

The last two series of experiments indicate that the cervical sympathetic nerve participates in the light reflex of the pupil only in that its continuous impulses maintain a tonic contraction of the dilator muscle which enhances the effect of relaxation of the sphincter in the dark; there is, however, no definite increase of excitation of the nerve in the dark.

In view of these experiments, particularly on account of the slightness of the impairment of the light reflex after cervical sympathectomy, the pathologic basis of the phenomenon of the Argyll Robertson pupil should not be sought in an impairment of the dilator innervation but of the reflex apparatus inducing contraction of the sphincter muscle.

Clinical Notes

MENINGIOMA OF THE SHEATH OF THE OPTIC NERVE

Report of a Case

J. GRAFTON LOVE, M.D., AND C. WILBUR RUCKER, M.D., ROCHESTER, MINN.

A woman aged 48 came to the Mayo Clinic on June 13, 1938, complaining that the vision in her right eye had been slowly failing for two years. She had no other complaints. Physical and neurologic examinations yielded only negative results, except for the presence of a tremor in the head and both arms, with the cogwheel phenomenon, which was interpreted as being caused by a hereditary striatal disorder and not as being related to the presenting complaint.

Vision in the right eye was 6/20 and in the left 6/6. The reaction of the right pupil to light was slightly diminished; the reaction of the left was prompt. Both pupils reacted normally on convergence. Ophthalmoscopic examination revealed a mild pallor of the right optic disk without loss of substance. The left fundus appeared to be normal. Perimetric fields showed a temporal contraction of the field for the right eye and a normal field for the left (chart 1), indicating the presence of a lesion involving the right optic nerve. Roentgenograms of the head and the sphenoid and ethmoid sinuses and localized roentgenograms of the sella turcica and optic canals all were reported as disclosing nothing suggestive of abnormality. Because of the slowly progressive nature of the visual loss, the presence of a tumor was suspected, and transfrontal craniotomy and surgical exploration of the right optic nerve were advised. The patient decided to defer the operation and went home.

She returned to the clinic on August 15. Her visual acuity had not changed, but the isopter for the 1/1,000 test object was smaller than it had been at the first examination (chart 2), demonstrating additional loss in vision.

On August 17, with the patient under intratracheal ether anesthesia, a right transfrontal craniotomy, such as is used for exposure of pituitary tumors and other lesions in the region of the optic chiasm, was performed.[1] The exposure was extradural to the right wing of the sphenoid bone; then the dura mater was opened, and the optic nerves and chiasm were exposed.

Immediately a small, firm, well encapsulated tumor, 1.25 cm. in diameter, was found on the mesial and inferior aspects of the right optic nerve. The tumor appeared to be extruding intracranially from the optic canal. Because of the situation of the tumor and the fact that it appeared to have its origin within the orbit, it did not seem wise to attempt removal of the tumor without first unroofing a portion of the orbit and the optic canal.[1]

From the Section of Neurologic Surgery (Dr. Love) and the Section of Ophthalmology (Dr. Rucker), the Mayo Clinic.

1. Love, J. G.: Transcranial Removal of an Intra-Orbital Meningioma, Proc. Staff Meet., Mayo Clin. **10**:213-215 (April 3) 1935. Benedict, W. L., and Love, J. G.: Cavernous Hemangioma of the Orbit with Hyperostosis, Am. J. Ophth. **22**: 1149 (Oct.) 1939.

The posterior two thirds of the roof of the right orbit was removed with a rongeur after the roof of the orbit was perforated with a burr. The roof of the optic canal also was removed. It was then noted that the tumor extended beneath the optic nerve in the canal and slightly to the lateral side of the nerve as well. Most of the tumor lay on the dorsal aspect of the right optic nerve. The tumor, the intracranial dura mater and sheath of the optic nerve, which were involved by the tumor, were resected en masse. It was then noted that the right optic nerve was markedly constricted at the site at which the tumor lay in the optic canal but that the color of the nerve was practically normal. The left optic nerve and chiasm appeared to be normal.

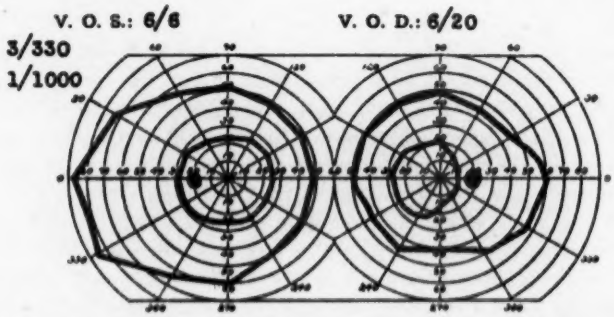


Chart 1.—Visual fields taken on June 14, 1938. There was temporal contraction of the field for the right eye; the field for the left eye was normal.

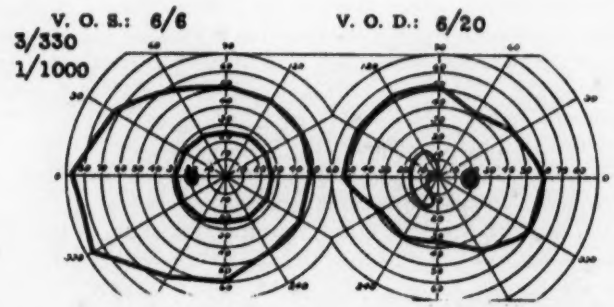


Chart 2.—Visual fields taken on August 15. There was an increase in the temporal contraction.

After careful attention to hemostasis, the bone flap was tied in place with three double silk sutures, and the wound was closed in layers. A Penrose cigaret drain was inserted between the bone flap and the scalp and left in place as a precautionary measure. During the course of the operation a transfusion of 500 cc. of blood was administered. Histologic study of the tumor by Dr. Kernohan resulted in a report of meningioma.

After the operation the patient was febrile for ten days. During the first few days she had severe headache and mild meningismus. On the eighth day postoperatively, because of the continued fever and meningismus, a diagnostic puncture of the spinal column in the lumbar segment was performed. Because of the patient's

muscular rigidity and hypersensitiveness, it was necessary to introduce the needle after the patient had been anesthetized with pentothal sodium (sodium ethyl 1-methyl butyl thiobarbituric acid) administered intravenously.

The cerebrospinal fluid was found to be grossly discolored by old blood, and the spinal subarachnoidal pressure was increased. A sample of the fluid was subjected to a smear test and culture, results of which were negative.

After the lumbar puncture and removal of the hemorrhagic fluid, the patient became much more comfortable. The procedure was repeated the next day, at which time the fluid was much clearer. The next day the temperature was normal

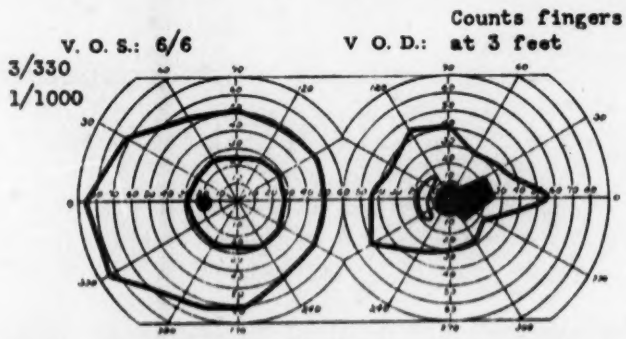


Chart 3.—Perimetric fields thirteen days after operation, on August 30.

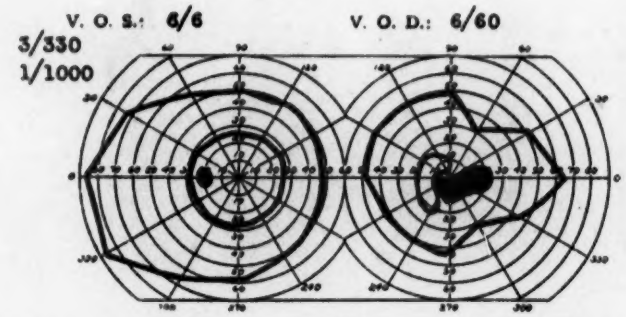


Chart 4.—Perimetric fields three and a half months after operation, on December 1.

and remained so. It was not necessary to puncture the spinal canal again. The patient's further convalescence was entirely uneventful.

On August 30 vision in the right eye was found to be diminished to ability to count fingers at 3 feet (90 cm.); it was 6/6 in the left eye.

The right visual field contained a large dense cecocentral scotoma (chart 3). The patient was dismissed on September 2, at which time her incision had healed well and her general condition was excellent.

When the patient returned for observation on December 1 vision in the right eye had improved to 6/60. The cecocentral scotoma partly spared the macula, and the temporal contraction of the field had become lessened (chart 4). Ophthalmoscopic examination disclosed moderate pallor of the right optic disk.

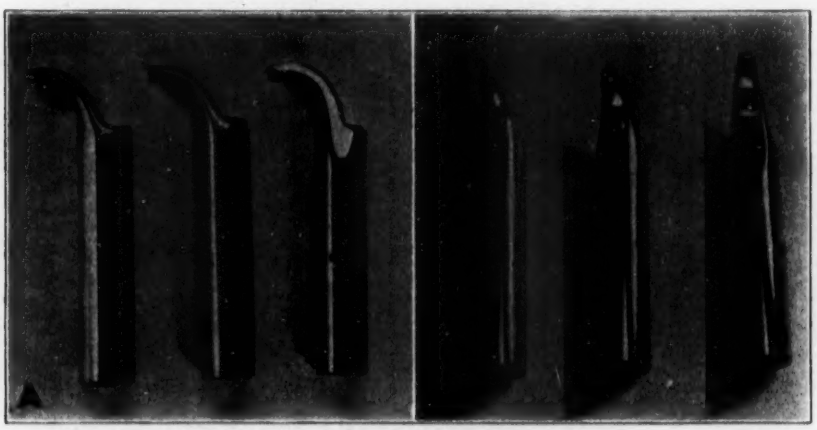
COMMENT

In this case a benign growth arose on the sheath of the optic nerve. It is interesting to note that all roentgenograms of the skull, including special views of the optic canals and lesser wings of the sphenoid bone, were normal. Ordinarily meningiomas on or about the lesser wing of the sphenoid bone give rise to osteomatous formations. The initial symptom, loss of vision and studies of the perimetric fields permitted early recognition and removal of the meningioma.

NEWLY DESIGNED THERMOPHORE CONDUCTORS

HAROLD F. WHALMAN, M.D., LOS ANGELES

For twelve years I have found the Shahan thermophore the most satisfactory means of applying heat to various superficial parts of the eye, because of the accuracy of temperature regulation with this instrument. However, the conductors designed for the original instrument were somewhat awkward to apply, as the entire instrument had to be balanced in a vertical position.



Three newly designed conductors (*A*, side view, and *B*, front view). Obviously variations can be made in the contact surfaces if desired.

Two years ago I had several conductors made with curved tips which were found to have a number of advantages. The instrument is more easily applied from a horizontal position; the curved tip allows better observation of the region to which it is applied, and it is possible on account of the curvature of the tip to reach areas inaccessible with the straight tip, as in treating retinal separations.

AN INEXPENSIVE DISPOSABLE EYE DROPPER

DAVID D. WAUGH, M.D., BROOKLYN

The eye dropper, to the ophthalmologist, has long been an unsatisfactory device. Although it is theoretically possible to instil drops without contaminating the eye dropper, practically the rate of contamination is rather high. Although solutions used for the eyes are not sterile, it is hoped that there are no virulent organisms in them as prepared by the druggist. If such an organism is introduced from a previous patient, serious consequences may result.

In order to obviate this possibility, several procedures have been adopted. Individual droppers, cleaned and sterilized in-between patients, and platinum wire loops, sterilized by flame, have been used. Cotton-tufted tooth picks, disposed of after use, have also been employed. The disadvantages of these procedures, as well as others too numerous to mention, are evident.

An inexpensive, disposable eye dropper was sought as a possible solution to the problem. As manufactured, it should be reasonably sterile, with little chance of virulent organisms being present. It should be capable of sterilization by steam and pressure.

Cellophane, in the form of soda or drinking "straws," was tried. The straws were cut into 4 inch (10 cm.) lengths, and one end was folded on its transverse axis about 5 mm. from the end. This manipulation was repeated, making a double fold. Finally, the end containing the seal was folded in the direction of the long axis of the straw. A permanent tight seal results. This cellophane tube sealed at one end was found to pick up 3 drops of water, each of which was equivalent to 0.05 cc. The drops are easily expressed under simple control. Each tube can be sealed in less than ten seconds. They can be sterilized at 30 pounds' (13.6 Kg.) pressure for thirty minutes if properly packaged to prevent bending.

At present these straws are sold in the five and ten cent stores, 10 cents for 65, 8 inches (20 cm.) in length. It is hoped that they may some day be sold already sealed and sterilized.

Ophthalmologic Reviews

EDITED BY DR. FRANCIS HEED ADLER

THE OPTIC PATHWAY

LEO L. MAYER, M.D.
CHICAGO

At the recent meeting of the American Medical Association in St. Louis I placed on exhibit materials used in the teaching of neuro-ophthalmology at Northwestern University Medical School.[1] The great general interest shown and the many questions asked have prompted the present article.

It is only within the past fifty years that the anatomic relation of the optic pathway in the brain has been studied with the intent to explain clinical manifestations of interference due to disease. Because of the three-dimensional relation of the optic pathway to the brain, it has been difficult to demonstrate to students a clear and retainable picture. It has been my purpose to gather together from many and various sources anatomic and clinical reports, drawings and models, and from this conglomeration to construct models and drawings which have made simple both the teaching and the learning of this subject.

Drawings of the dorsal, basal and lateral aspects of the brain with the optic pathway, as shown in figures 1 and 2, readily localize the relation in a simple manner without confusing detail. The simple line drawing shown in figure 3, taken from Duke-Elder,[2] readily makes clear the neuron hook-up.

Gross dissection of the brain to demonstrate the optic nerves, the chiasm, the optic tracts and the radiations is not difficult; but to point out the surrounding structures does not tend to leave lasting memory pictures. An excellent dissection by Wolff [3] is shown in figure 4.

Exposure of the optic pathway to injury and disease throughout its extent from the eye to the occipital lobe and its superficial position along the base of the brain as far as the external geniculate body make for frequent interference and change in the visual field.

---

1. Mayer, L. L.: Optic Pathways in the Brain, J. A. M. A. **112**:1494 (April 15) 1939.

2. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1933, vol. 1.

3. Wolff, E.: The Anatomy of the Eye and Orbit, Philadelphia, P. Blakiston's Son & Co., 1936.

By tracing the fibers of the optic pathway in an anteroposterior direction from the eye to the occipital cortex, one is able to localize morbid processes better. The nerve fibers in the retina are so arranged that radiation takes place from the nasal side toward the optic nerve

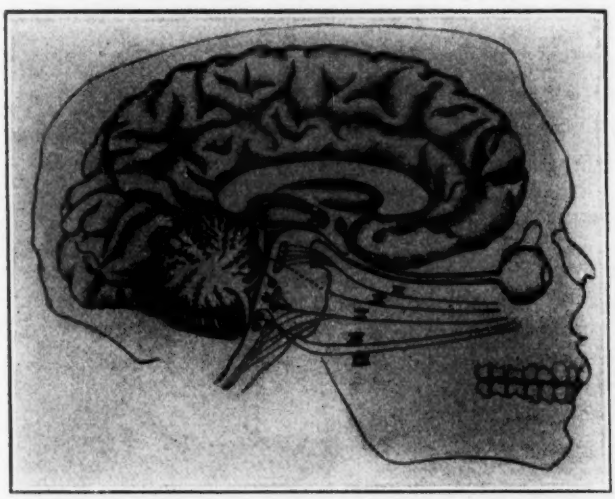


Fig. 1.—The nerve connections of the eye and brain.

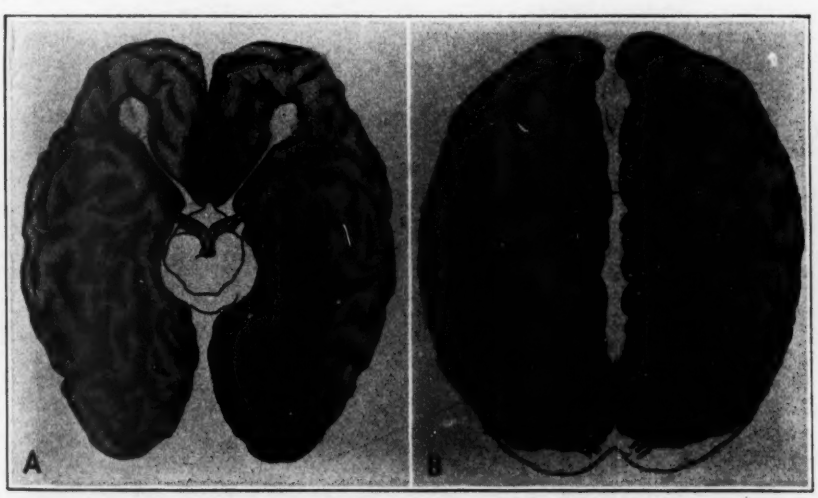


Fig. 2.—*A*, basilar view of the optic pathways. *B*, dorsal view of the optic pathways.

head, while from the temporal side the fibers arch around the macular area. Thus a lesion of the fibers near the optic disk will produce a defect in the field of vision corresponding to that area of the retina served by these fibers. A characteristic lesion of such a nature is

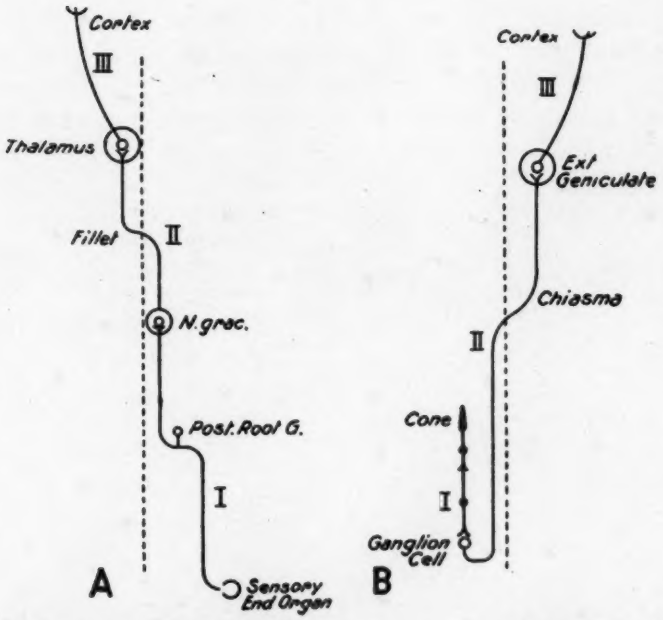


Fig. 3.—*A*, the path of somesthetic sensation. *B*, the visual path. (From Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1933, vol. 1.)

Fig. 4.—Dissection (from the side) to show the blood supply of the optic pathway and the relations of the vessels to the oculomotor nerves. (From Wolff, E.: The Anatomy of the Eye and Orbit, Philadelphia, P. Blakiston's Son & Co., 1936.)

found in glaucoma, in which the increased intraocular tension has caused damage to the fibers entering the papilla. From the degeneration experiments of Brouwer and Zeeman [4] it has been noted that fibers lying together in the retina maintain a corresponding relation in the optic nerve until the chiasm is reached, when the crossed fibers of each bundle pass over to the opposite side. Since the temporal fibers in the retina are arched, the central area may be preserved in complete obstruction of the central artery, as the nerve fiber raphe extends only to the macular area. A form of incongruity in the defects of the visual field may occur owing to the fact that the extreme nasal periphery of the retina has no corresponding area in the temporal portion of the retina of the opposite eye. Hence fibers from the nasal periphery form a group of crossed fibers, which when reaching the optic tract are not met by companion fibers. A lesion interrupting the mesial fibers of the radiation on one side may cause a homonymous hemianopia without affecting the extreme temporal portion of one field, leaving a so-

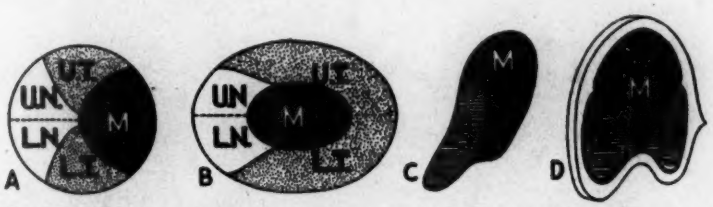


Fig. 5.—Distribution of the visual fibers: *A*, in the distal portion of the optic nerve; *B*, in the proximal portion of the optic nerve; *C*, in the optic tract, and *D*, in the lateral geniculate body. The crescents below *U.P.* and *L.P.* are the uniocular fibers. *M* indicates the macular fibers; *U.T.*, the upper temporal fibers; *L.T.*, the lower temporal fibers; *U.N.*, the upper nasal fibers; *U.P.*, the upper peripheral fibers, and *L.P.*, the lower peripheral fibers. (From Brower, B., and Zeeman, W. P. C.: Brain **49**:1, 1926.)

called temporal crescent. Posterior to the globe in the optic nerve the fibers lie in fibrous trabeculae derived from the pial sheath and are grouped as shown in figure 5. As the macular fibers have now reached the center of the optic nerve, a lesion of this bundle will cause a central scotoma without indication as to the level affected. However, as the posterior end of the optic nerve is approached, a fibrous septum separates the crossed and the direct fibers, thus producing the possibility of a hemianopic scotoma, in which a lesion may affect one set of fibers alone. Also in this region of the chiasm, since the direct fibers lie on the outer side of the nerve, there may be caused a lesion producing nasal or binasal hemianopia, according to whether one or both of the direct portions of the nerves are involved. Complete severance

4. Brouwer, B., and Zeeman, W. P. C.: The Projection of the Retina in the Primary Optic Neuron in Monkeys, Brain **49**:1, 1926.

of the function of one optic nerve produces blindness in the ipsilateral eye. Because of the close proximity of the optic nerve with the sphenoid and posterior ethmoid air cells in its interosseous portion, inflammation of these sinuses may give rise to retrobulbar neuritis. It has been hypothesized that because of their highly developed physiologic function the fibers of the papillomacular bundle are to be regarded as having a special vulnerability; hence the frequency of retrobulbar neuritis. However, since the nutrition of the optic nerve is provided by small end-arteries from the pial sheath and since the macular fibers lie at the center of this vascular network, it seems more rational to

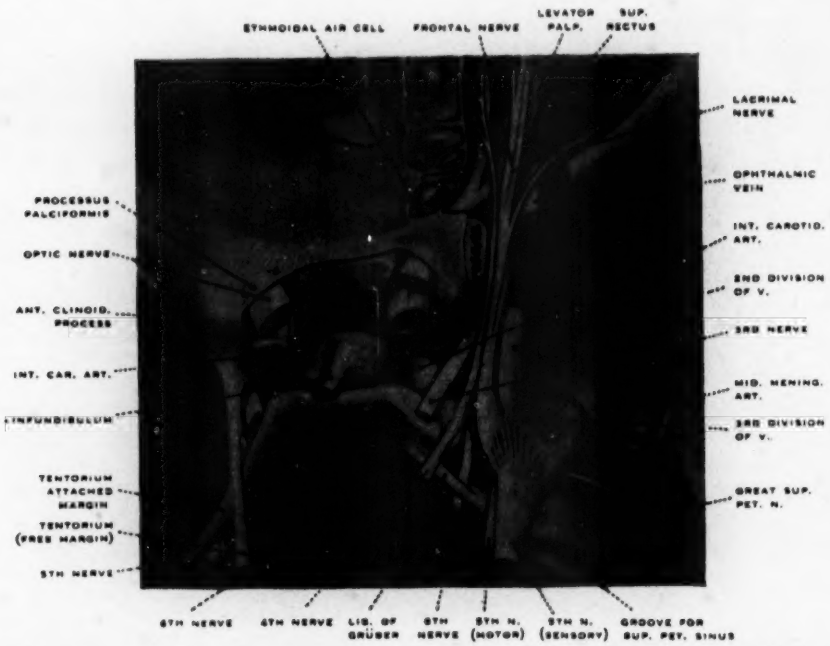


Fig. 6.—Dissection to show nerves passing from the middle cranial fossa into the orbit. (From Wolff, E.: The Anatomy of the Eyes and Orbit, Philadelphia, P. Blakiston's Son & Co., 1936.)

believe that the macular fibers are least accessible to the blood supply and most easily affected by inadequate drainage. Thus an anatomic basis is provided. As the optic nerve emerges from its osseous canal, it is overhung by the sharp edge of a fold of dura mater, which crosses the body of the sphenoid bone between the anterior clinoid processes. In this free and mobile portion, because of its relation, numerous factors may cause interference. Above lie the frontal lobe and the anterior communicating artery. Below and slightly externally is the carotid artery, outside of which is the cavernous sinus. To the inner side is the olivary eminence of the sphenoid bone and at a slightly

lower level the pituitary body. It is unnecessary to explain in further detail what effect lesions in this area will have on the optic nerve. The splendid dissection by Wolff, reproduced in figure 6, shows the

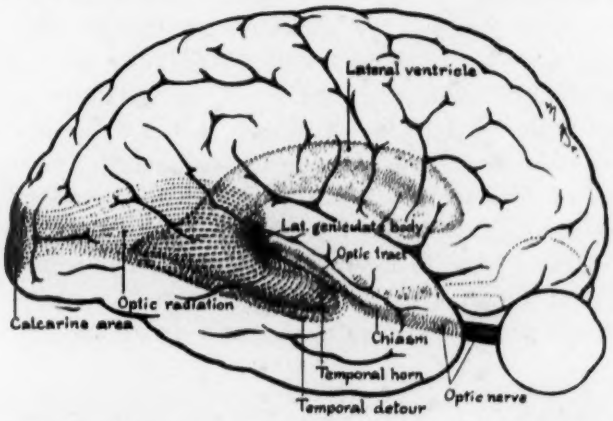


Fig. 7.—Geniculocalcarine pathway from the outer side, showing the temporal detour of the optic radiations. (From Cushing, H., and Walker, C. B.: Brain **37**:524, 1915.)

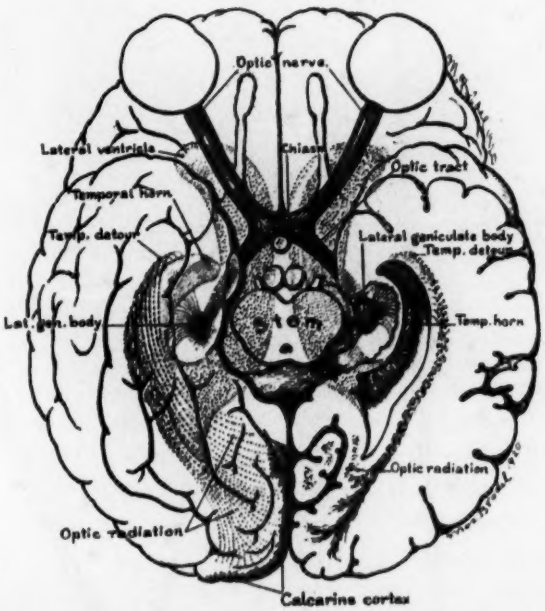


Fig. 8.—Inferior aspect of the pathway in transparency in the right hemisphere, indicating that the loop reaches as far forward in coronal section as the chiasm. In the left hemisphere the pathway is shown on section. (From Cushing, H., and Walker, C. B.: Brain **37**:524, 1915.)

important structures in this area. The important relation of the pituitary body has been emphasized by the work of Cushing and Walker [5] and of de Schweinitz.[6]

Caudad from the chiasm, the visual fibers continue in the optic tract, which passes upward and backward around the crus, covered on its outer and inferior aspect by the temporal lobe, to terminate in the external geniculate bodies. Sketches from Cushing and Walker's article show these relations, as in figures 7, 8 and 9. In the tract the direct fibers from one retina become associaed with the crossed fibers from the other, so that a single lesion produces homonymous defects in the visual fields of the two eyes. Fibers from corresponding minute areas of the retina come gradually to lie side by side, and the apposition is not complete until the upper part of the tract is reached. Because of this arrangement, a lesion in the lower part of the tract may affect

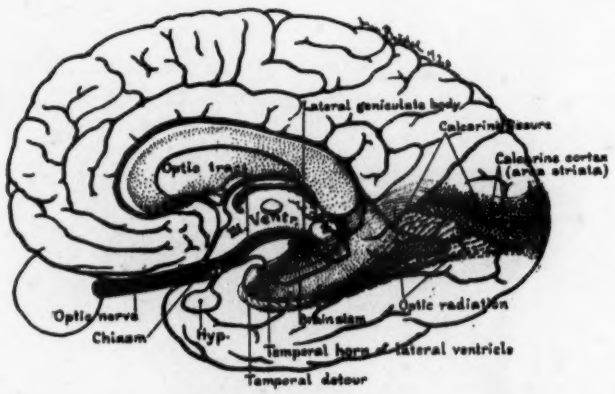


Fig. 9.—Geniculocalcarine pathway from the mesial side, showing the temporal detour of the optic radiation. (From Cushing, H., and Walker, C. B.: Brain **37**:524, 1915.)

more fibers from one side than from the other, and thus hemianopic defects which are unequal in onset, extent and intensity may be produced in the two fields. This type of defect has been called the incongruous type of homonymous hemianopia and is indicative of a lesion below the geniculate body. The so-called congruous type of homonymous hemianopia is found in lesions affecting the geniculate body and the radiations posterior to it. It is characteristic of suprageniculate lesions and makes for some degree of localization of the lesion.

---

5. Cushing, H., and Walker, C. B.: Chiasmal Lesions with Especial Reference to Bitemporal Hemianopsia, Brain **37**:524, 1915.

6. de Schweinitz, G. E.: Concerning Certain Ocular Aspects of Pituitary Body Disorders, Mainly Exclusive of the Usual Central and Peripheral Hemianopic Field Defects, Tr. Ophth. Soc. U. Kingdom **43**:12, 1923.

The optic fibers may be traced caudad from the external geniculate body to the occipital visual cortex. The classic description by Henschen[7] was modified by the investigations of Adolph Meyer.[8] Meyer showed that instead of the radiations passing directly backward into the retrolenticular part of the posterior limb of the internal capsule, their course is forward and downward into the anterior portion of the temporal lobe. Here a loop is formed, passing over and around the anterior horn of the lateral ventricle, then turning backward to the anterior portion of the inferior lip of the calcarine fissure. Figures 10 and 11, taken from models made by Pfeifer,[9] show this deviation. Quadrantic hemianopia is frequently caused by lesions of the temporal lobe affecting this portion of the radiations. The cortical representation of the visual fibers on the occipital pole are shown vividly by the diagram of Holmes[10] in figure 12.

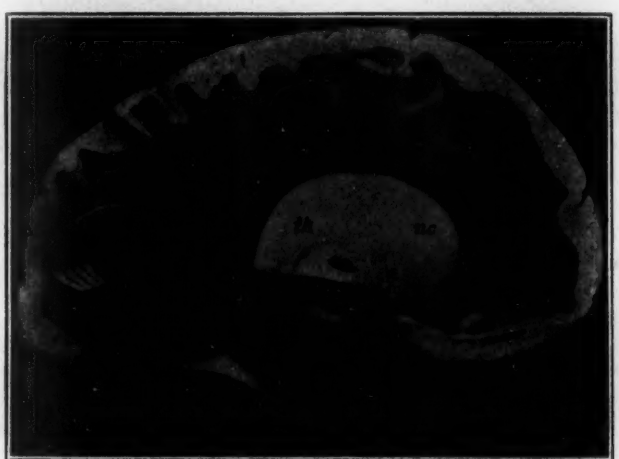


Fig. 10.—Model of the brain showing the deviation of the optic nerve fibers. The thalamus is indicated by *th;* the caudate nucleus by *nc;* the internal geniculate by *cgi;* the internal capsule by *ci;* the anterior commissure by *ca;* the external geniculate by *cge,* and the optic tract by *tro.* (From Pfeifer, R. A.: Myelogenetisch-anatomische Untersuchungen über den zentralen Abschnitt der Sehleitung, Berlin, Julius Springer, 1925.)

One factor of homonymous hemianopia known as sparing of the macula, a retention of the central field, occurs in the majority of cases.

7. Henschen, S. E.: Zur Anatomie der Sehbahn und des Sehzentrums, Arch. f. Ophth. **117**:403, 1926.

8. Meyer, A.: The Temporal Lobe Detour of the Radiations and Its Importance for the Diagnosis of Temporal Lobe Lesions, Tr. Am. Neurol. A., 1911, p. 201.

9. Pfeifer, R. A.: Myelogenetisch-anatomische Untersuchungen über den zentralen Abschnitt der Sehleitung, Berlin, Julius Springer, 1925.

10. Holmes, G.: A Contribution to the Cortical Representation of Vision, Brain **54**:470, 1931.

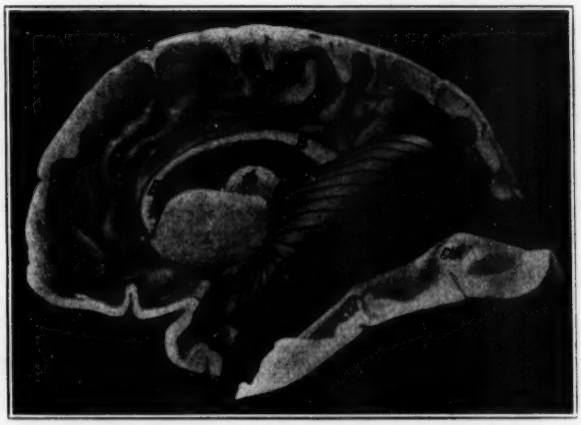


Fig. 11.—Model of the brain showing the deviation of the optic nerve fibers. *B* indicates the corpus callosum; *nc*, the caudate nucleus; *th*, the thalamus; *cul*, the cuneus; *L*, the lenticular nucleus, and *cal*, the calcarine sulcus. (From Pfeifer, R. A.: Myelogenetisch-anatomische Untersuchungen über den zentralen Abschnitt der Sehleitung, Berlin, Julius Springer, 1925.)

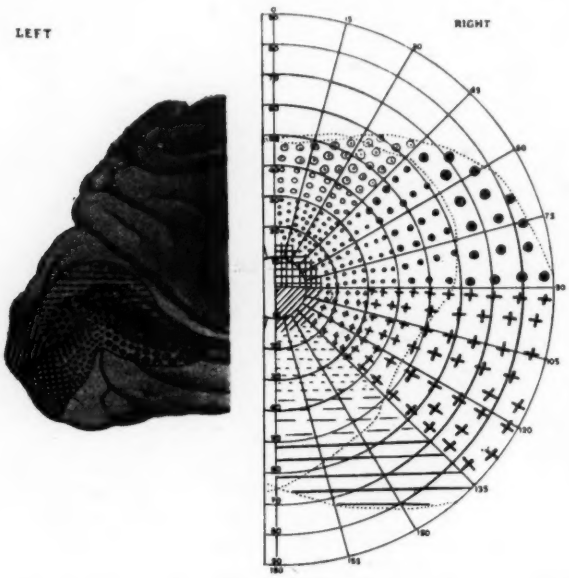


Fig. 12.—The cortical retina. The calcarine fissure is represented as widely opened. The macular area is relatively large and the peripheral area is relatively small. The areas of the visual field are marked correspondingly to their areas of cortical projection. (From Holmes, G.: Brit. J. Ophth. **2**:383, 1918.)

The explanation for this phenomenon is not conclusive. One school of thought feels that the macular area of each eye is connected to both sides of the occipital cortex. Another group points out that because

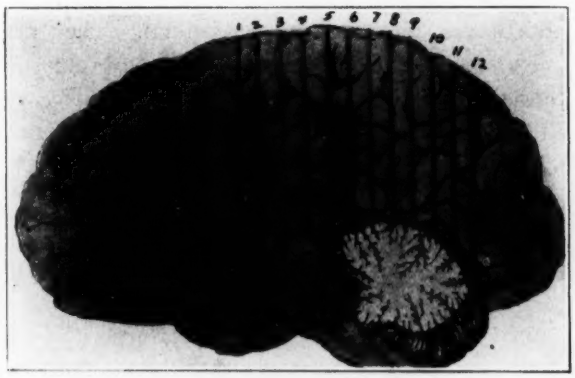


Fig. 13.—Location of serial sections of the brain.

Fig. 14.—First section of the brain model.

of the double vascular supply of the occipital pole by the middle cerebral as well as the posterior cerebral artery an anatomic situation is the basis. Occasionally the dividing line between the seeing and the blind areas passes directly through the fixation area.

In order to clarify further the situation of the optic pathway in the brain, a special model has been constructed at Northwestern Uni-

versity Medical School. It is based on a method which has been in common usage to demonstrate the various pathways of the spinal cord. Serial sections at various levels in the brain, as indicated by figure 13, were photographed and mounted. These sections, as will be noted, do not include the brain stem and the cerebellum. They are reproductions from Jelgersma's Atlas [11] of sections of the brain stained by the Pal-Weigert method and are enlarged to about twice normal size. Figure 14 is the first section of the series at the level of the chiasm.

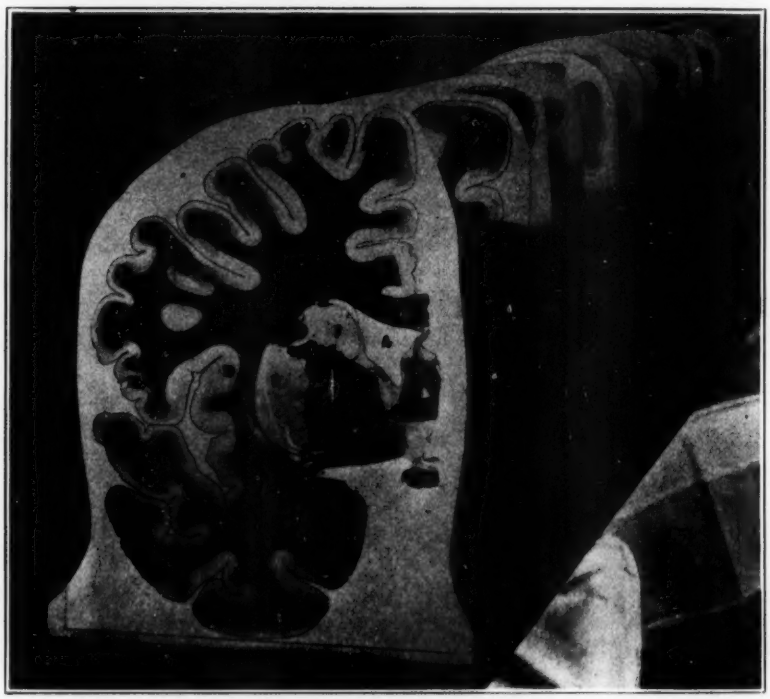


Fig. 15.—Model of sections of the brain.

The various important structures are numbered throughout the series, and certain letters are added to keep the continuity.

The following key is used to explain the sections: *1,* optic chiasm; *1A,* optic tract; *1B,* optic tract and lateral ventricle; *1C,* lateral geniculate body; *1D,* external sagittal stratum; *2,* anterior commissure; *3,* fornix; *4,* lateral ventricle; *4A,* inferior horn of the lateral ventricle; *4B,* posterior horn of the lateral ventricle; *5,* internal capsule; *5A,* retrolenticular part of the internal capsule; *6,* corpus callosum; *7,* caudate nucleus; *8,* globus pallidus; *9,* putamen;

11. Jelgersma, G.: Atlas Anatomicum Cerebri Humani, New York, Van Riemsdyck Bookservice, 1931.

10, insula; *11,* temporal lobe; *12,* anterior central gyrus; *13,* thalamus; *13A,* medial nucleus of the thalamus; *13B,* lateral nucleus of the thalamus; *13C,* pulvinar; *14,* amygdala; *15,* third ventricle; *16,* postcentral gyrus; *17,* hippocampus; *18,* basis pedunculi; *19,* substantia nigra; *20,* red nucleus; *21,* choroid plexus; *22,* lateral zone of Wer-

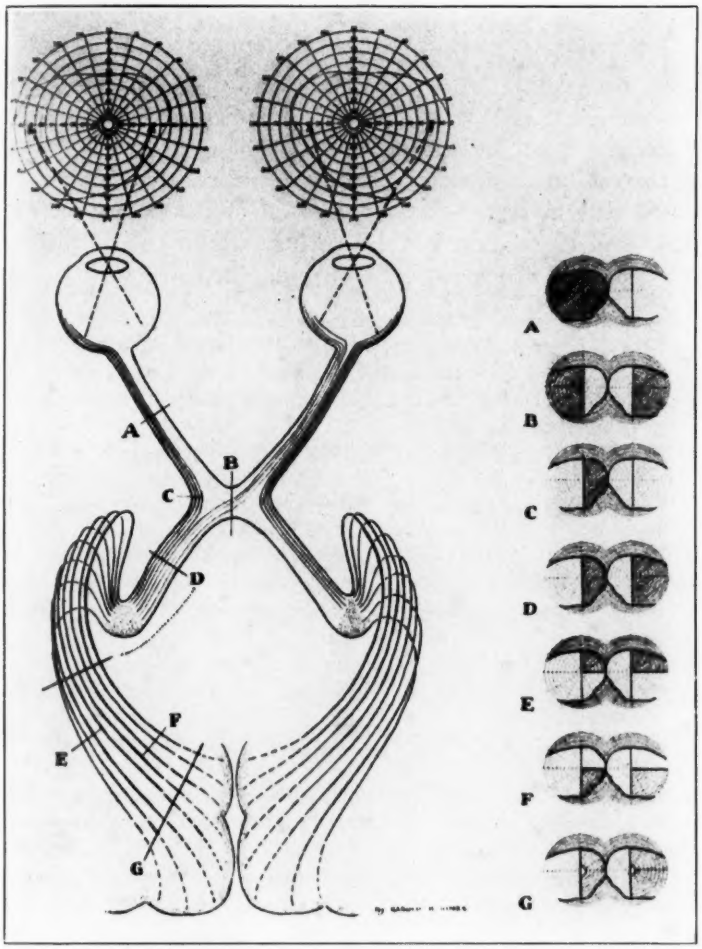


Fig. 16.—Classic field defects and the location of the lesion. (From Homans, J.: A Textbook of Surgery, Springfield, Ill., Charles C. Thomas, Publisher, 1936.)

nicke, *23,* supramarginal gyrus; *24,* superior colliculus; *25,* parietal lobe; *26,* lingual gyrus; *27,* calcarine fissure; *28,* line of Gennari, and *29,* cuneus. The twelve photographed sections were mounted on cardboard, cut to size with a jig saw, and fixed at intervals of 6 inches (15 cm.) on a slotted board 6 feet long (183 cm.). A red string

joins all the sections and indicates the optic pathway as shown in figure 15. By a detailed study of the model on anatomic as well as on physiologic lines, a clear conception of the optic pathway and its environs is registered.

The classic field defects caused by lesions in various portions of the pathway have been well depicted in Homans' drawing.[12] Slightly modified and enlarged, this drawing is reproduced in figure 16. The works of the following investigators, in addition to those previously mentioned, have added much to the knowledge of this field: Monakow,[13] Wilbrand,[14] Ariëns Kappers,[15] Minkowski,[16] Rönne,[17] Lenz,[18] Behr,[19] Putnam [20] and others.

The correlation of anatomic structure and relation with subjective symptoms exists in regard to every system of the body. In the case of vision, this correlation can be perhaps more easily and exactly demonstrated than in connection with other systems.

Interest and assistance in this work have been contributed by Prof. S. W. Ranson, of the Neurological Institute; Prof. Lewis J. Pollock, of the Department of Nervous and Mental Diseases, and Prof. Sanford R. Gifford, of the Department of Ophthalmology, all of the Northwestern University Medical School.

---

12. Homans, J.: A Textbook of Surgery, Springfield, Ill., Charles C. Thomas, Publisher, 1936.

13. von Monakow, C.: Die Lokalisation im Grosshirn und der Abbau der Funktion durch kortikale Herde, Wiesbaden, J. F. Bergmann, 1914.

14. Wilbrand, H.: Ueber die Organisation der kortikalen Fovea und die Erklärung einiger Erscheinungen aus dem Symptomenkomplex der homonymen Hemianopsie, Ztschr. f. Augenh. **54**:1, 1925; Schema des Verlaufs der Sehnervenfasern durch das Chiasma, ibid. **59**:135, 1926.

15. Ariëns Kappers, C. U.; Huber, G. C., and Crosby, E. C.: The Comparative Anatomy of the Nervous System of Vertebrates, Including Man, New York, The Macmillan Company, 1936.

16. Minkowski, M.: Zur Physiologie der Sehsphäre, Arch. f. d. ges. Physiol. **141**:171, 1911.

17. Rönne, H.: Zur pathologischen Anatomie der diabetischen Intoxikationsamblyopie: Beitrag zur Pathogenese der neurogenen Zentralskotome, Arch. f. Ophth. **85**:489, 1913.

18. Lenz, G.: Die histologische Localisation des Sehzentrums, Arch. f. Ophth. **91**:264, 1918.

19. Behr, C.: Die homonymen Hemianopsien mit einseitigen Gesichtsfelddefekt in "rein temporalen halmondformizen Bezirk des binokularen Gesichtsfeldes," Klin. Monatsbl. f. Augenh. **56**:161, 1916.

20. Putnam, T. J., and Putnam, I. K.: Studies on the Central Visual System: I. The Anatomic Projection of the Retinal Quadrants on the Striate Cortex of the Rabbit, Arch. Neurol. & Psychiat. **16**:1 (July) 1926. Putnam, T. J.: II. A Comparative Study of the Form of the Geniculostriate Visual System of Mammals, ibid. **16**:285 (Sept.) 1926; III. The General Relationships Between the External Geniculate Body, Optic Radiation and Visual Cortex in Man, ibid. **16**:566 (Nov.) 1926; IV. The Details of the Organization of the Geniculostriate System in Man, ibid. **16**:683 (Dec.) 1926.

News and Notes

UNIVERSITY NEWS

Graduate Courses, Harvard Medical School.—As usual, Harvard Medical School is offering a course in recent advances in ophthalmology from May 6 to June 1 and a course in visual optics and physiology from July 1 to July 27. These are advanced courses and are not open to beginners.

The course in recent advances in ophthalmology is designed to give a cross section of the ophthalmic work at the Massachusetts Eye and Ear Infirmary. However, it is based primarily on Dr. Terry's course in clinicopathologic ophthalmology, in which correlation of clinical findings with the pathologic changes is stressed. In addition to the lecture work on pathology, laboratory exercises are given, during which time the student has an opportunity to study in some detail the hundred class slides as well as to see many unusual specimens from the collection of demonstration slides.

Visual optics and physiology, under Dr. Ludvigh, is introduced by one week of rapid review of the fundamental principles, to serve as a basis for the more advanced work. The subject matter includes reflection, refraction, refractive errors of the eye, accommodation, ophthalmoscopy, retinoscopy, reduced eye, aberrations of the eye, ocular motility, binocular vision, relation between retinal structure and function, visual acuity, light sense, color vision and color blindness, entoptic phenomena, impulses of the optic nerve, visual illusions, pupillary reflexes and intraocular pressure. Instruction includes lecture and laboratory work.

Although no formal announcement of the course in fundamental sciences in ophthalmology for beginners has been made for next autumn, applications may be sent in now. Further information concerning all courses in ophthalmology may be obtained from the Assistant Dean, Courses for Graduates, Harvard Medical School, Boston.

SOCIETY NEWS

Pan-American Congress of Ophthalmology.—A Pan-American Congress of Ophthalmology will be held in Cleveland on Oct. 11 and 12, 1940. The members of the committee in charge of developing the program are Dr. Conrad Berens, New York; Dr. Harry Gradle, Chicago, and Dr. Moacuy E. Alvaro, São Paulo, Brazil.

The official language of the congress will be Spanish, Portugese and English. All ophthalmologists are eligible to membership in the congress on registration and payment of the $5 fee. Until the committee is in session, all business pertaining to the congress can be transacted through Dr. W. P. Wherry, executive secretary of the American Academy of Ophthalmology and Otolaryngology, which has undertaken the arrangements to facilitate the institution of the congress.

Individual invitations to attend the congress will not be sent to ophthalmologists in the United States and Canada. This notice will be taken as the official invitation.

PERSONAL

Dr. Alfred Bielschowsky (1871-1940).—Dr. Alfred Bielschowsky, director of the Dartmouth Eye Institute, died in Brooklyn on Jan. 6, 1940, at the age of 68, after a brief illness. He was born in a German Silesian village on Dec. 11, 1871. He studied medicine at the universities of Breslau, Heidelberg, Berlin and Leipzig, receiving his medical degree from the University of Berlin in 1894. He came to the Dartmouth Eye Institute in 1934 as visiting ophthalmologist and was appointed visiting lecturer in physiologic optics in 1935. He was professor of ophthalmology and director of the institute from 1937 until his death.

Acta ophthalmologica orientalia.—Dr. Aryeh Feigenbaum, of Jerusalem, Palestine, editor of *Acta ophthalmologica orientalia,* writes that this journal will appear bimonthly in the future and that later a conversion into a monthly review is contemplated. Suitable papers will be appreciated.

Notices

Cumulated Index of the Archives of Ophthalmology.—Requests have been received for a ten year index of the ARCHIVES OF OPHTHALMOLGY. Before serious consideration is given to the production of a cumulated index, it is desirable to know whether the demand for it would be sufficient to warrant its sale at not to exceed $5 a copy; that is, whether one thousand copies could be sold. It will be appreciated if those who are interested in such an index will fill out and send the form which appears below to the Managing Editor at the publication office, 535 North Dearborn Street, Chicago.

I SHOULD BE WILLING TO SUBSCRIBE TO A CUMULATED INDEX OF THE ARCHIVES OF OPHTHALMOLOGY AT $5.00.

NAME.....

ADDRESS.....

.....

DATE.....

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Biochemistry

THE SIGNIFICANCE OF THE CAROTENOIDS IN RELATION TO THE EYES. P. KARRER, Docum. ophth. **1:** 259, 1938.

The carotenoids are discussed, and their structural formulas as well as those of related compounds are presented. The literature is reviewed, and the relation of vitamin A and visual purple to the carotenoids is given. The author is of the opinion that the carotenoids are probably not directly concerned with vision in view of their marked resistance to light. This further leads him to infer that they may serve as filters which permit only light of certain wavelengths to reach the photolabile substances.

E. G. SMITH.

Conjunctiva

A CASE OF PRIMARY LUES IN THE SUPERIOR FORNIX. I. CZUKRASZ, Brit. J. Ophth. **23:** 347 (May) 1939.

A physician 40 years of age had mucous patches coughed into his right eye. Four weeks later the lids became swollen; the conjunctiva was red and presented follicles in the superior fornix with slight hypertrophy of the tarsal conjunctiva. The preauricular glands were painful and swollen. No bacteria or inclusion bodies were found. The Wassermann reaction was negative. The condition became worse, and about two weeks later there was a 4 plus Wassermann reaction. It was impossible to obtain material for a spirochete test. After the fifth injection of neoarsphenamine the appearance changed, and after the first antisyphilitic treatment the eye healed entirely without scars. This, the author considers, verified the diagnosis of primary syphilis of the superior fornix.

W. ZENTMAYER.

Congenital Anomalies

HEREDITARY AND FAMILIAL MEGALOCORNEA. P. BEIL and L. SARRAZIN, Ann. d'ocul. **176:** 241 (April) 1939.

Cases of this curious affliction while rare are important. Although Mayer in 1808 in a thesis alluded to familial deformities of the cornea, it was Horner who first studied the question.

Megalocornea is a domelike deformity of the cornea appearing at birth. The cornea is otherwise regular and clear, only the limbus presenting a characteristic opacity. The vertical and horizontal diameters range between 12 and 16 mm. The normal curve is variable, and generally there is astigmatism. The visual clearness is frequently normal. The expansion of the anterior segment is striking, and the anterior

chamber is enlarged in all its dimensions. Iridodonesis is nearly always present, and the lens does not follow the enlargement of the anterior segment but remains normal in volume.

For many years this ocular malformation is compatible with good sight and may not affect the patient's vision until between the fortieth and the fiftieth year, when bilateral cataract appears, frequently associated with dislocation of the lens.

Three patients, two brothers and a cousin, were seen by the writer, and the details of the examination are given. Concerning the treatment of this condition and the results obtained, Weil, of Strasbourg, reported cases in which operation was successful. He noted, as did Horner, that the lens keeps a normal volume and does not follow the anterior chamber in its hypertrophy.

Four illustrations and a bibliography accompany the article.

S. H. McKee.

Cornea and Sclera

"Inflated" Interstitial Keratitis. E. Cornet, Ann. d'ocul. **176:** 297 (April) 1939.

The author described in 1938 a bizarre corneal lesion in patients with corneal conjunctival trachoma which he called "inflated" interstitial keratitis. The lesion consists first of interstitial keratitis, usually central or paracentral, with recent dendritic vascularization due to its distance from the limbus. It is always associated with a marginal trachomatous pannus with two distinct areas of recent vascularization in different planes.

Also, in the center of this zone of parenchymatous infiltration the cornea is swollen, sometimes presenting epithelial depressions, which do not take a fluorescein stain. At the same time a recent intense vascularization appears. The vascularization is superimposed on the interstitial vascularization and shows the characteristics of the vascularization of repair.

Two cases are reported.

S. H. McKee.

Transplantation of the Cornea of the Cadaver. I. Wasserman, Vestnik oftal. **14:** 10, 1939.

Filatov started using the cadaver's cornea in 1931. Up to March 1938 he and his assistants had performed 281 transplantations of the conserved cadaver's cornea, while the use of the cornea from the living eye dwindled to a minimum. In 1937 114 keratoplasties were performed, and for only 2 of these was the living cornea used.

This article presents a thorough analysis of the transplantation of the cadaver's cornea in 72 cases during 1936. The transplantation was done on one eye of 66 patients and on both eyes of 2 patients, and 1 patient underwent reoperation on the same eye. In 37 patients, or in 51 per cent, there was a transparent taking of the cornea; in 15, or in 20 per cent, a semitransparent taking, and in 20 cases, or 27.8 per cent, a nontransparent taking. The age of the patients varied from 7 to 56 years. The cornea was preserved mostly in the blood of the donor. Two

corneas were kept in an aqueous solution of brilliant green, and one cornea was kept in an egg yolk. The cadavers' eyes were enucleated from two to sixteen hours after death, and the transplantation was performed from eight to sixty-three hours after death and in 2 cases as long as eight and one-half days after death.

The technic of the operation and the postoperative course are described in detail by Wasserman. The opacification of the transplant usually clears by the end of the third month and remains clear. The most frequent complication is the increase of tension, which requires additional operations for glaucoma; iritis and iridocyclitis are also frequent complications.

Vascularization of the cornea appears within two or three weeks after the operation. Successful results with the conserved cornea of the cadavers are twice as high as those with the living eye. The two largest world centers of corneal transplantation (Dr. Elschnig, in Prague, and Dr. Filatov, in Odessa) give the good results of transparent taking of the living cornea as about 28 per cent, while the good results with the cadaver's cornea are 58 per cent.

The author's conclusions follow:

1. The conserved cornea of the cadaver is the best material for corneal transplantation.

2. The transplantation of the cadaver's cornea gives transparent taking of the cornea in 58 per cent as compared with 20 or 28 per cent with the living eye.

3. Transparent taking of the transplant was obtained while conserving it from one to three days. In 2 cases the transplant was conserved eight and one-half days and gave a transparent taking.

4. In the transplantation of the cadaver's cornea the blood vessels appearing at the transplant are few and are obliterated sooner than when the eye from the living person is used.

O. SITCHEVSKA.

General Diseases

THE PROBLEM OF OCULAR TUBERCULOSIS. A. C. WOODS, Am. J. Ophth. 21: 366 (April) 1938.

Woods discusses ocular tuberculosis from the standpoint of diagnosis and therapeusis. He draws the following conclusions:

"1. The diagnosis of ocular tuberculosis must be based on the course and character of the lesion, on the exclusion of other etiological factors, and on a study of the general tuberculous status of the patient. The tuberculin reactions are of value only when strongly positive. Weak or negative reactions are of no significance for or against the diagnosis of ocular tuberculosis.

"2. The therapeutic problem centers on a proper conception of the influence of allergy and immunity on the local tuberculous lesion. The therapeutic aim should be to abolish allergy and promote immunity. Tuberculin finds its greatest value when used on the desensitization concept over a long period of time. Immunity can be promoted only by general measures.

"3. There are contraindications to tuberculin in certain cases. There are wide gaps in our knowledge of the relation of skin and ocular sensitivity and of the proper administration of tuberculin."

W. S. REESE.

SOME MANIFESTATIONS OBSERVED IN NORTHERN AFRICA OF HEREDITARY AND ACQUIRED SYPHILIS AT THE LEVEL OF THE CORNEOSCLERAL MARGIN. F. SCHOUSBOE, Ann. d'ocul. **176:** 376 (May) 1939.

This article consists of a series of clinical observations which the author was able to make in the course of a prolonged stay in the Algerian highlands and in the populous indigent quarters of Algiers.

For purposes of explanation, the author has chosen four illustrations which demonstrate: (1) segmentary nodular interstitial keratitis, (2) nodular scleroconjunctivitis and (3) nodular sclerokeratitis. He has described the conditions under the headings of symptoms, clinical forms and diagnosis. A table giving data as to sex, age, antecedents, objective symptoms, presence of trachoma and treatment in 30 cases is presented.

The author found that ocular syphilis was more frequent in children from the fifth to the tenth year (63 per cent) and more frequent in the females than in adult males. The condition is frequently unilateral in children and usually bilateral in adults. It is often associated with trachoma; scrofula and tuberculosis may often create "border cases."

S. H. MCKEE.

Glaucoma

AETIOLOGY OF GLAUCOMA. P. WEINSTEIN, Brit. M. J. **1:** 436 (March 4) 1939.

Weinstein studied the possible relation of glaucoma to blood pressure. The study showed that the systolic blood pressure of 100 sound persons ranged from 120 to 200 mm. of mercury and the diastolic pressure from 60 to 95 mm., while the corresponding values for 150 persons suffering from glaucoma were 120 to 230 mm. and 60 to 115 mm., respectively. The difference is not sufficient to suggest the existence of hypertonia in glaucomatous persons. Attention was next directed to the small vessels, but no values that are characteristic of the tension of glaucoma could be determined either within the large vessels or within the precapillaries. It was found, however, that when the ocular tension increases, the pressure within the intraocular vessels increases also but that that of the extrabulbar vessels does not. Müller and Parrisius discovered by capillaroscopy that the vasomotor instability of glaucomatous persons was a characteristic peculiarity. Mészáros, Tóth and the author came to the same conclusion. The reactive hyperemia (the filling up of the bloodless finger with blood, normally within one or two seconds) is prolonged in glaucomatous persons. These data seem to prove that the capillary pressure increases in glaucoma. During investigations by means of the tonograph, the author observed that there is a difference between the amplitude of the oscillations of glaucomatous

hypertonic persons and that of persons with thrombosis of the central retinal vein. The tonographic reading for glaucomatous persons at 200 mm. of mercury pressure shows a normal oscillation of from 8 to 10 mm. against over 15 mm. for thrombotic persons, proving that there is a decrease of elasticity in the walls of the vessels. Inflammatory glaucoma rarely occurs in persons suffering from grave arteriosclerosis (nephrosclerosis and diabetes), but their capilloscopic reading, as well as their tonographic reading and dermal tension value, differs from that found in glaucoma. The acute capillary dilatation observed during glaucomatous attacks is possible only with an elastic wall of the vessels and not with the rigid walls of arteriosclerotic persons. Of the 3,254 glaucomatous patients from the First Ophthalmological Clinic from 1904 to 1933 and of the smaller series from the ophthalmologic department of the policlinic, 60 per cent were women, and 80 per cent of the acute attacks befell women at the time of the climacteric. This ratio explains the relation of glaucoma to the endocrine system and renders the vasomotor instability of glaucomatous persons easily understood, as during the climacteric women are disposed to congestion, perspiration and similar vasomotor reactions. The frequency of glaucomatous attacks in winter is conspicuous. This connection with meteorologic conditions again points to vasomotor instability of the capillaries. Primary glaucoma, in contrast to the inflammatory type, develops because of arteriosclerotic alteration and accordingly does not show any great increase in ocular tension. The destruction of the optic nerve seems to be the sequel to the circulatory defect and to the resulting alimentary deficiency. The third type of glaucoma is that which follows thrombosis of the central retinal vein. As a rule the victims are persons of advanced age whose blood pressure is high and the amplitude of whose tonographic reading is large. In whatever organ thrombosis may be located, pathologic products, such as carbonic acid, lactic acid, citric acid and hydrochloric acid, accumulate, and this must necessarily be the case within the eye. It is probable that under the influence of these substances the vitreous body slowly begins to swell and gradually increases the ocular tension, and glaucoma in these cases of thrombosis of the central retinal vein is probably caused by an alteration in the hydrogen ion concentration.

J. A. M. A.

Injuries

OCULAR INJURIES IN INDUSTRY: MEDICOLEGAL ASPECT. R. YANES, Rev. cubana de oto-neuro-oftal. 7: 3 (May-June) 1939.

The author covers the medicolegal aspects of ocular injuries in industry, stressing the importance of this subject in regard to the economic problems of indemnification involved by those persons who carry insurance.

He describes the legal processes obtaining in Cuba, giving details of the initial medical certificate, medical inspection of the injured, obligation of the workman and all other relations between the doctor treating the patient and the courts.

Special attention is given to incapacity of the workman. The proper procedures are discussed for the evaluation of visual acuity of the

traumatized eye and the relative industrial incapacity of the patient in conformity with the most just computation. The question of medical fees is also taken up, and the author suggests the desirability of the introduction of a clinical traumatologic unit which would specifically concern itself with such honorariums.

The article concludes with a notation of certain practical points for the discovery of malingering among those injured whose desire it is to obtain greater compensation.

S. L. RHODE.

Instruments

A BI-CYLINDRICAL TYPE READER. G. B. LOWE, Brit. J. Ophth. **23**: 212 (March) 1939.

The glass described in this article is based on the fact that the height of a letter form is well known to increase the legibility, owing to the reading sight traveling along the top of the print. When the lower half of a line of print is seen, the line can scarcely be read.

The glass consists of two plano-cylindric lenses of 6 diopters each, lying back to back on the horizontal, giving an effective power of 12 diopters. The handle of the glass is set obliquely to allow an easy wrist hold. A black line is etched across the lower third of the glass as a guide for holding it properly, so that the print is seen truly vertical when the black line rules along the type below the reading level.

One illustration accompanies the article.

W. ZENTMAYER.

Lens

CATARACT FROM PHENOL DINITRITE: REPORT OF TWO CASES. J. SEDAN, Ann. d'ocul. **176**: 191 (March) 1939.

The question of the treatment of obesity by phenol dinitrite dates from 1933, when it was brought forward by the work of the Americans Tainter, Mehrtens and Cutting. These authors reported that the ingestion of dinitrophenol accelerated metabolism, with marked elevation of temperature. It was estimated by Horner that in fifteen months after the appearance of the drug on the market 5,000 persons used it for reduction of weight. Serious incidents became so numerous that the American Medical Association warned the public of its danger.

The author observed 2 cases of cataract due to this cause. In 1 case development of the opacity of the lens showed arrest after stoppage of the dinitrophenol. The cases are given in detail.

A bibliography accompanies the article.

S. H. MCKEE.

MAINTENANCE OF THE CRYSTALLINE LENS. R. WEEKERS, Compt. rend. Soc. de biol. **131**: 140, 1939.

The lens kept in Ringer's solution at 37 C. dies in a few hours intoxicated by the products of its own metabolism. Establishing a circulation of the fluid demonstrates the inadequacy of Ringer's solution as a nutrient medium. But Ringer's solution can be sufficiently enriched by previously

injecting it in the abdominal cavity of a rabbit and withdrawing the fluid two to three hours later (Bakker: *Arch. f. Ophth.* **136:** 333, 1936). The liquid is freed of formed elements by centrifuging. Though this perfusion medium differs from aqueous in many respects, being much lower in dextrose content and much higher in nitrogen, it nevertheless maintains the lens for a long time in normal metabolism and perfect transparency.

J. E. LEBENSOHN.

Neurology

MENINGIOMAS OF THE BRAIN. G. HORRAX, Arch. Neurol. & Psychiat. **41:** 140 (Jan.) 1939.

The sections of this review on meningiomas arising from the olfactory groove and on orbital temporal meningiomas are of special interest to the ophthalmologist. The first type of meningioma results in atrophy of the optic nerve with loss of olfactory sense on the same side, mental change and finally increased intracranial pressure with choking of the optic disk on the uninvolved side. The second type results in marked and gradually increasing protrusion of one eye due to the enormous bony thickening of the orbital roof and of the bone lateral to and beneath the orbit in the region of the sphenoid ridge, together with invasion of the orbit posteriorly by the tumor, which has extended through the bone from its intracranial origin.

R. IRVINE.

ACQUIRED SPASMS OF THE ELEVATOR MUSCLE OF THE UPPER LID. G. E. JAYLE, Ann. d'ocul. **176:** 173 (March) 1939.

This article is continued from the January number of the *Annales d'oculistique* and reports in detail 1 of 3 cases of monocular spasm of the elevator muscle of the upper lid seen by the author.

He concludes that spasm of the elevator muscle of sympathetic or undetermined origin appears to be characterized by the following features: (1) involvement of the two lids or just the lower; (2) the constant presence of a palpable phenomenon, such as exophthalmos; (3) the frequent occurrence on a sympathetic endocrine basis, and (4) the absence of signs tending to show a focus in the central nervous system.

Spasms of the elevator muscle of the lids, binocular or monocular, permanent or intermittent, possess therefore histologic characteristics and also certain pathogenic ones. The histologic characteristics consist of an elective localization of spasm of the upper lid, its habitual association with oculomotor disturbances and its frequent association with signs of a focal peduncular lesion, among which vestibular and postural troubles have an important place. The pathogenic characteristics are the origin, the focus of the lesion in the upper peduncular or the subpeduncular region (with perhaps an exception for certain of the synkinetic monocular spasms), the mechanism and probable disturbances of functional association at the site of the elevator muscle of the lid.

Five illustrations accompany the article.

S. H. MCKEE.

Ocular Muscles

THE TREATMENT OF CONCOMITANT CONVERGENT STRABISMUS. E. A. VORISEK, Am. J. Ophth. **21**: 1356 (Dec.) 1938.

The data on 183 cases of monocular and 62 cases of alternating squint are given, and the methods used for refraction and for measuring the squint are discussed. The following conclusions are drawn:

"In general, the possibilities of obtaining a recovery or an improvement are much better in the monocular group, while the treatment of the alternating group is definitely unsatisfactory.

"The percentage of unsatisfactory results found in the group of children with alternating convergent strabismus are exactly double those found in the group with monocular strabismus." W. S. REESE.

Operations

EPITHELIAL INLAY WITH KERR-MATERIAL TO FORM AN EYE SOCKET. I. CZUKRASZ, Brit. J. Ophth. **23**: 343 (May) 1939.

The method described is a modification of the Esser inlay procedure. The principle of the method is to get the exact impression of the prepared cavity with stent (the author uses Kerr's mass, which is of the same nature). This mold showing the anatomic form of the cavity is the temporary prosthesis, the support to keep the inlay in its place.

In Czukrasz' opinion, its greatest advantage does not lie in the exact adaptation of the flap which provides for the adhesion and nutrition but in the fact that with its help the inlay can be fixed circularly to the bony orbital margin. This avoids effectually and definitely the postoperative shrinking. The hollow is made by cutting with the knife circularly to the bone so that the cavity will extend really to the bony margin. Naturally the mold takes this form exactly; therefore, the flap is also fixed circularly to the bone.

It has one disadvantage, that is, that a large canthotomy is necessary. Otherwise there might be difficulty in putting in and taking out of the mold. But this is not of great importance, as it is richly compensated by the excellent permanent result.

The method was tried in the ophthalmic clinic of Debrecen in 2 cases.

The article is illustrated. W. ZENTMAYER.

Parasites

OPHTHALMOMYIASIS. J. R. B. MCBRIDE, Brit. M. J. **1**: 670 (April 1) 1939.

A case is reported in which the larvae of Oestrus ovis, the common head maggot fly of sheep and goats, were found in the conjunctiva. When these larvae are deposited in the conjunctival sac, intense conjunctival hyperemia and pain usually result. The dark chitinous hooks on the head of the larva cling to the conjunctiva. The patient, a girl of 15 years, became conscious of a pricking in her eye while reading in the garden. About two hours later she consulted her physician. The pain became

gradually worse. She was unaware that a fly struck her eye. When the conjunctiva was examined, eight maggots were discovered and were removed. Their mobility was amazing. They were difficult to dislodge, as they clung to the conjunctiva by the two hooks at the head. It took three quarters of an hour to remove the eight, and after two hours' rest two others were removed. The following day the redness had subsided, and in two days the eye was normal.

ARNOLD KNAPP.

Pharmacology

EFFECT OF CILIARY BODY EXTRACT ON OCULAR TENSION. D. MICHAIL and P. VANCEA, Compt. rend. Soc. de biol. **130**: 1041, 1939.

A small dose of ciliary body extract (0.6 Gm. dried weight) injected intravenously in the dog produces a rise of ocular tension of 3.7 mm. of mercury. A simultaneous tracing of the arterial blood pressure indicates that this change is due to vascular variation in the eye rather than to hypersecretion of aqueous.

J. E. LEBENSOHN.

THE PRESENCE OF SULFANILAMIDE IN THE TEARS, AQUEOUS AND VITREOUS AFTER THE USE OF ORGANIC SULFUR DERIVATIVES FOR THEIR ANTIBACTERIAL EFFECT. L. VERICO, Ann. di ottal. e clin. ocul. **67**: 30 (Jan.) 1939.

In tears collected from patients receiving sulfanilamide by mouth, the author obtained definite evidence of the presence of the sulfonamide group by qualitative tests. The intensity of the reaction varied with the dose of the drug. Similar reactions were obtained with the aqueous and vitreous of rabbits two to three hours after the administration of 0.2 to 1 Gm. of sulfanilamide by stomach tube. The reaction persisted for thirty-six hours as a rule. Various sulfonamide compounds were employed, the best reactions being obtained with sulfanilamide.

S. R. GIFFORD.

Physiology

LOCALIZATION OF PERIPHERAL PHOSPHENES PRODUCED BY ELECTRIC STIMULATION. A. CHWEITZER, Compt. rend. Soc. de biol. **130**: 1204, 1939.

Results were tabulated after applying the cathode to the lower lid with the subject fixing at a red spot 2 meters distant in dim light. The phosphenes are localized generally to the right or left side according to the eye excited, whether the nasal or temporal portion of the lid is stimulated, and are usually referred to the upper part of the field.

J. E. LEBENSOHN.

THE WATER MECHANISM OF THE EYE AND ITS PARTS. F. P. FISHER, Docum. ophth. **1**: 79, 1938.

A comprehensive review of the water mechanism of the eye is presented, comprising water intake, combination, production, trans-

formation and output and various related phases. Part 1 deals with the water content, metabolism and combination in the various tissues. Part 2 outlines the significance of water in the various physiologic processes of the parts of the eye, including nutrition, optics, intraocular pressure and mechanics. Part 3 deals with the water mechanism in the pathologic eye. Diseases of the outer layers, the uvea, the retina and the vitreous and increased intraocular tension are taken up in detail. Part 4 is devoted to the influence of internal diseases. Under this heading are included the intoxications, infections, diseases of the glands of internal secretion, metabolic disorders, circulatory diseases and diseases of the central nervous system. The last part of the article deals with the effect of pharmacologic and physical therapeutic measures. Subconjunctival, intravenous and local medication as well as the effects of heat, radiant energy and electricity are considered.

A lengthy and excellent bibliography is included.

E. G. SMITH.

Refraction and Accommodation

PROGRESSIVE MYOPIA (NEW TREATMENT WITH BASE-IN PRISMS). W. M. THOMPSON and O. B. NUGENT, Illinois M. J. **75:** 231 (March) 1939.

Thompson and Nugent believe that they have developed a treatment for progressive myopia which practically covers every phase of the etiology involved. They have found it extremely successful in all cases of axial progressive myopia and less so in the more complicated types, but worth trying in all. The first step in the treatment is the making of the prescription for glasses. The total error is ascertained. Then from 20 to 25 per cent of the sphere is removed, and the prism is found by adding prisms, base in, until diplopia is produced. The prism is neutralized until monocular vision is accomplished. The remaining prism is used base in, half over each eye. The next step is to place the lens as near to the patient's eye as possible without its touching the cilia. This is for the scientific reason that the longer the focal distance, the larger the object appears to the myopic eye, and therefore the less the strain on it. The third step consists of special exercises with the myoculator. The patient is seated 4 feet (122 cm.) from the machine, wearing the proper prescription and 3 diopters of prism, base in, over each eye in addition. The eyes should be exercised for ten minutes, three times a week. The time may be increased slowly up to twenty minutes. As a fourth step the patient must have special class work, special large type in the books read and good lighting, either natural or artificial. All use of the eyes for close work must be carefully supervised and a time limit used. The fifth step is the compilation of a diet list which will give the patient a properly balanced vitamin intake. The last step is called "medication," which consists of the use of cod liver oil and iron, quinine and strychnine for rebuilding the muscle power involved. The authors conclude that whatever else may be used in the treatment of myopia of any type, the eyes should be prevented from converging, and for this they advise prisms, base in.

J. A. M. A.

Retina and Optic Nerve

RETINAL EXAMINATIONS: GUIDE IN MANAGEMENT OF TOXIC HYPERTENSIVE SYNDROME OF PREGNANCY. R. D. MUSSEY and B. J. MUNDELL, Am. J. Obst. & Gynec. **37**: 30 (Jan.) 1939.

Mussey and Mundell point out that the weight of evidence indicates that acute late toxemia of pregnancy presents a hypertensive syndrome, characterized by general spasm of the smaller arteries. The degree of the spasm appears to parallel the height and duration of the blood pressure and the severity of the toxemia. Examination of the arterioles of the retina reveals changes which apparently manifest the degree of angiospasm throughout the body. In addition to hypertension and other symptoms, the presence and persistence of noticeable retinal vascular spasm is a guide to the management of late toxemia. This often indicates the need of avoiding further generalized and perhaps permanent vascular damage by terminating pregnancy when the condition of the patient permits. On the contrary, retinal changes of comparatively mild degree or their absence may indicate that pregnancy may be allowed to continue in the hope of obtaining a living infant without unduly jeopardizing the health and life of the mother. J. A. M. A.

CEREBROSPINAL FLUID IN OPTIC NEURITIS, "TOXIC AMBLYOPIA" AND TUMORS PRODUCING CENTRAL SCOTOMAS. A. L. WATKINS, New England J. Med. **220**: 227 (Feb. 9) 1939.

Of 120 patients who came to the hospital because of failing vision, the condition of 40 was diagnosed as acute retrobulbar neuritis. Watkins concludes that the cerebrospinal fluid in such cases is normal except when the neuritis is associated with multiple sclerosis. In these cases, which form from 20 to 50 per cent of the group, the colloidal gold curve may show a strong first zone reaction.

In 39 cases of chronic retrobulbar optic neuritis the onset of the visual disturbance was slow and gradually progressive over a period of months rather than weeks. The average age in this group (39 years) was somewhat higher than that in the cases of acute involvement (33), with 62 per cent of patients more than 40 years of age. Both eyes were affected slightly more frequently (54 per cent) than one alone, and the eyeballs were tender and painful in only 22 per cent of cases. Pallor of the optic disks was usually observed (72 per cent), but the disks were hyperemic in 21 and normal in 7 per cent. The characteristic field showed a central scotoma, and the visual impairment had progressed to nearly complete blindness. Lumbar punctures revealed no abnormality in initial pressure, cellular content, total protein or colloidal gold curve. The causation was unknown in 85 per cent of the cases and proved to be multiple sclerosis in 15 per cent.

The average age in the 30 cases in which a diagnosis of "toxic amblyopia" was made was 52. The course was one of slow progressive loss of vision in the two eyes, although not necessarily equally. The eyeballs were in no case tender, and the optic disks were either normal or slightly pale. The diagnosis was made from examinations of the visual fields, the characteristic field showing a cecocentral scotoma, although in

some cases diagnosis was made from a history of overindulgence in alcohol and tobacco and the presence of a central scotoma similar to that seen in cases of retrobulbar neuritis. Forty per cent of these patients improved after reducing or stopping the use of tobacco or alcohol. Examinations of the cerebrospinal fluid showed initial pressures which were usually normal. The total protein averaged 33 mg. per hundred cubic centimeters, being distinctly abnormal in only 2 cases. The colloidal gold curve was negative in all cases.

Another group of 5 patients with optic neuritis showed a diminution of vision, papillitis and a constricted field of vision. These patients were between 4 and 44 years of age. There was tenderness of the eyeball in only 1 case. There was slight choking of the optic disks and peripheral constriction of the visual fields, and some of the patients had only unilateral involvement. Lumbar punctures showed normal initial pressures. The condition in all cases was of fairly rapid onset, and normal vision was regained. Pansinusitis occurred coincidentally in 2 cases and hay fever in another. One patient had a definite lead intoxication, which seemed of etiologic significance.

Of 6 other patients with optic neuritis, 3 had transverse lesions of the spinal cord and retrobulbar neuritis, which was thought to be on an unclassified infectious basis but fitted into the clinical syndrome of optic neuromyelitis. The other 3 had blindness with central scotomas and multiple peripheral neuritis. Necropsy in 1 of these cases revealed extensive periarteritis. In the 3 cases of optic neuromyelitis and the 2 of multiple peripheral neuritis with optic neuritis there was definite abnormality of the cerebrospinal fluid. In the case of periarteritis the fluid was normal.

In an additional 22 cases of tumor and failing vision the author found that the cerebrospinal fluid pressure, cellular content and colloidal gold curve may all frequently be within normal limits but that the total protein is usually increased from two to five times the normal when a central scotoma is present due to pressure of a tumor or an aneurysm on the optic nerves or chiasm.

J. A. M. A.

VITAL STAINING OF THE RETINA: PRELIMINARY CLINICAL NOTE. A. SORSBY, Brit. J. Ophth. 23: 20 (Jan.) 1939.

The clinical exploration of the possibility of vital staining of the retina had become feasible with the finding of dyes that behaved like basic dyes as far as staining of the central nervous system was concerned and were in addition nontoxic. The experimental observation that the damaged retina retained the color suggested the possibility that the diseased retina in man might behave similarly. The dye used throughout in clinical work was Kiton fast green V, and after preliminary toxicity tests on monkeys the clinical dose was gradually built up.

At this stage it is not feasible to indicate the full clinical possibilities of vital staining of the retina. The method of use thus far evolved and a few observations are all that can be given.

The method of administration follows: A 10 per cent solution of Kiton fast green is prepared by dissolving the dye at 60 C., filtering twice at 35 C., and sterilizing by tyndallization. From 20 to 30 cc. of this solution, warmed to body heat, is injected intravenously. After

the first 3 or 4 cc. the patient assumes a faint greenish color, which deepens as more dye is injected. At the end of the injection the patient is deep green, the face being greener than the rest of the body. The color deepens during the first half hour and begins to fade after three or four hours; generally it disappears for all practical purposes within eight to ten hours. The dye is excreted mainly through the kidneys, and the urine remains colored for two or three days.

The author made the following clinical observations: As the dye is not selective for the retina, lesions other than those of the retina are demonstrated. The blood vessels themselves do not stain, but exudates, whether choroidal or retinal, take up the dye avidly. There is no advantage to be gained by using the dye for this purpose, as these changes are visible ophthalmoscopically. With the doses used so far the retina in cases of atrophy of the optic nerve does not stain; in several cases all that has been observed has been a toning down of the normal red reflex. The atrophic disk itself does, however, stain green, and a suggestive finding has been obtained in 1 case in which vision in one eye was 6/60 and ophthalmoscopically the appearance of the fundus was normal; on injection, the normal eye did not stain; the eye with defective vision had a distinctly green coloration of the disk. (In this case a dose of 40 cc. was given.) Suggestive results have also been obtained in cases of detachment of the retina. In 1 case the detachment, while not becoming green with an injection of 30 cc., lost its normal color, and in the subdued background a series of tears which were previously not visible were clearly seen as red boles. In another case, illustrated with a color plate, a large disinsertion which had not been observed on an exhaustive ophthalmoscopic exploration became visible after injection of the dye (20 cc.), the edge of the retina at the disinsertion becoming distinctly green and standing out in marked contrast to the red area uncovered by the disinsertion.

In view of the fact that the normal retina discolorizes all the dye that reaches it and that coloration seems to depend on the degree of inefficiency of the retina, it is obvious that equally deep staining is not to be expected in cases in which there are unequal degrees of retinal damage. Furthermore, as the dose necessary for staining experimentally damaged retina in the rabbit (from 5 to 8 cc.) suggests that higher doses than those so far employed clinically will have to be used, these preliminary observations are offered as showing not the scope of vital staining of the retina but the fact that the procedure is feasible.

One colored plate accompanies the article. W. ZENTMAYER.

OCULAR CHANGES ASSOCIATED WITH NAEVUS FLAMMEUS. J. J. EVANS and R. J. EVANS, Brit. J. Ophth. 23:95 (Feb.) 1939.

The author gives the following summary and conclusions:

"Two cases of naevus flammeus associated with optic atrophy and other changes are reported. It is held that the optic atrophy follows upon defective nutrition of the nerve resulting from abnormal vascular supply, and is not secondary to, nor dependent upon, a rise of intra-ocular tension.

"In the one case there was increased intra-ocular tension on at least one, and probably on several, occasions during a long history; in the other case no increase of tension has been observed during a period of

thirteen years. It is held that certainly in the latter case, and possibly in the former also, optic atrophy is independent of changes in the intraocular pressure.

"The second case presents the rare opportunity of microscopic examination of a haemangioma of the choroid and particularly of the course of entry of the haemangiomatous tissue into the globe. The first case shows the presence of associated cranial vascular abnormalities and of irradiation cataract."

A number of illustrations accompany the article.

W. ZENTMAYER.

PAPILLEDEMA AND HYPERTENSION. I. AASLAND, Nord. med. (Nørsk mag. f. lægevidensk.) **1**: 108 (Jan. 14) 1939.

Aasland says that while the causation of the various disorders in which choked disk may appear differs, the common factor in all is arterial hypertension. He thinks that the extreme form of choked disk with intracranial pseudotumor occurs only in malignant hypertension. The picture of pseudotumor depends on arterial hypertension in the cranial blood vessels with secondary symptoms of circulatory insufficiency in the form of general edema and increased intracranial pressure. The increased pressure of the cerebrospinal fluid which is often present in malignant hypertension is assumed to be an accessory factor in the mechanism of choked disk. Two cases of intracranial pseudotumor associated with malignant hypertension are reported. There was bilateral papilledema of 5 and about 7 diopters, respectively. The blood pressure varied from 230 to 250 mm. of mercury. In the second case the pressure of the cerebrospinal fluid rose to 360 mm. No signs of renal disease were established in either case. Necropsy revealed no evidence of cranial tumor. In spite of recommended treatment, such as intravenous injection of hypertonic solutions, repeated lumbar puncture and depression craniotomy, the prognosis is grave. According to statistics, 90 per cent of the cases are fatal within two years after the beginning of the hypertensive changes in the eyeground, and most of the remaining 10 per cent are fatal within the next two years.

J. A. M. A.

Trachoma

CONTAGIOUSNESS OF TRACHOMA AMONG ADULTS. E. PUSCARIU and E. TRIANDAF, Rev. internat. du trachome **16**: 24 (Jan.) 1939.

The authors demonstrated adult infection with trachoma from other adults in 945 cases. The disease was contracted by 293 men in the army, by 345 patients in the family and by 9 patients in the workshop. It is particularly noteworthy that 84 women acquired the infection from their husbands.

J. E. LEBENSOHN.

ETIOLOGIC PROBLEM OF TRACHOMA, WITH ESPECIAL REFERENCE TO THE BODIES OF PROWAZEK AND TO RICKETTSIAE. V. SPADAVECCHIA, Ann. di ottal. e clin. ocul. **67**: 1 (Jan.) 1939.

The literature on the causation of trachoma is reviewed, and various theories are discussed. The author concludes that the true value of

the Prowazek bodies has not been determined and that the question whether these bodies may be considered as members of the Rickettsia group has not been solved. He suggests as neccessary steps in the solution of these problems a more thorough study of the clinical types of human and experimental trachoma, further cytologic studies of the cells of the epithelium and follicles, more varied animal inoculations, further attempts to cultivate the virus and a more detailed study of the bodies considered as representing the virus.

An extensive bibliography accompanies the article.

S. R. GIFFORD.

Tumors

SPINDLE CELL SARCOMA OF THE LIMBUS. G. ANASTASI, Ann. di ottal. e clin. ocul. **66**: 918 (Dec.) 1938.

A review of the literature revealed only 5 cases classified as spindle cell sarcoma of the limbus. The author's patient was a man of 64 who had noticed a nodule at the temporal limbus of the left eye. It had grown to a pedunculated bilobate mass which occupied one fifth of the corneal circumference and extended out about 4 mm. on the bulbar conjunctiva. It was removed and the base cauterized. There had been no recurrence after two years. Sections showed a spindle cell leukosarcoma. No pigment was present in the aqueous humor.

A bibliography and photomicrographs accompany the article.

S. R. GIFFORD.

Therapeutics

BENEFICIAL EFFECTS OF THE INTRAVENOUS INJECTION OF IODINE IN SOME DISEASES OF THE OPTIC PATHWAYS. A. RUBINO, Ann. di ottal. e clin. ocul. **67**: 140 (Feb.) 1939.

Fifteen cases are reported, including 8 of tobacco-alcohol amblyopia, 2 of acute retrobulbar neuritis and 5 of arachnoiditis. The patients with tobacco-alcohol amblyopia were given ten to fifteen injections of an Italian proprietary preparation of iodine daily or on alternate days. All had good results, including 2 who were permitted to smoke and drink as usual. Both persons with retrobulbar neuritis had a return of vision to nearly normal. The vision of those with arachnoiditis improved, and no further loss of vision was observed.

S. R. GIFFORD.

Society Transactions

EDITED BY W. L. BENEDICT

GERMAN OPHTHALMOLOGICAL SOCIETY

Fifty-Second Session, Heidelberg, Germany, July 4-6, 1938

First Scientific Session

Monday, July 4, 1938

PROF. ALFRED VOGT, ZURICH, SWITZERLAND, *Chairman*

DISTRIBUTION OF RODS AND CONES IN THE RETINA AND THE RELATION OF THIS DISTRIBUTION TO THE ISOPTERS OF THE VISUAL FIELD. PROF. HANS LAUBER, Warsaw, Poland.

Previous knowledge of the numerical ratio of rods to cones in the different portions of the retina is inadequate to explain the different behavior of the isopters in the nasal and in the temporal portion. Horizontal sections through different portions of the retina and meridional sections through the macula were examined for the purpose of studying this relation in the nasal and in the temporal portion at equal distances from the papilla. There was a definite difference in the ratios. In the region of the equator in the nasal portion of the retina, the ratio of rods to cones was 366:91, or 4:1; the ratio in the corresponding area of the temporal portion was 505:74, or 6.8:1. The quantitative relations do not alone determine the differences in retinal function, but they can in part explain them.

DISCUSSION

PROF. ADOLF JESS, Leipzig: The papillomotor differences in the two halves of the retina, familiarity with which has been gained through the research of von Hess and which play an important role in the determination of the hemianoptic fixed pupil, may serve as the explanation for the different behavior of the isopters, in view of the anatomic relations.

THE NEUTRAL LIGHT TESTER. PROF. A. TSCHERMAK-SEYSENEGG, Prague, Czechoslovakia.

I have devised a new instrument which was constructed by Zeiss, of Jena, and which I have designated as the neutral light tester. This instrument makes it possible for one to focus a field (1) with homogeneous radiation from a spectrum of strong dispersion and (2) with undivided light from a lamp which is to be tested, and thus to determine the three cardinal points of the spectrum (basic yellow, green and blue) with the neutralized eye and with the eye which is adapted to lamplight. To facilitate the making of permanent records, a wavelength scale of

three dimensions, I propose a method of punch marking. By use of a double slit system (after Hering and Tschermak-Seysenegg), the basic red can be included in the investigation.

Further, the instrument facilitates the comparison of color and brightness of a spectral light with that of a complex color filter light. With this instrument, laws of color diversion can be tested and numerically checked by the displacement of the cardinal points of the color circle, so that if the light has mixed colors all four cardinal points are moved. In contrast, if it has basic colors only, displacement of the two adjacent cardinal points results without change in the particular cardinal point itself or its contradictory, or countercolored, points. By means of this tester, one can prove that there occurs in the two individual eyes of an observer a characteristic numerical, simultaneous diversion, which shows the same direction as the chromatic diversion—however, on the average to a less degree. The eye adapted to daylight or bright lamplight is, as a rule, color diverted, and the cardinal points have a characteristic position which is different from that seen with the neutral eye. The latter position can be obtained by shutting off the light for three minutes.

For certain lamps, a compensation for the generally markedly excessive yellow can be obtained by the use of blue glass. This compensation is apparent, in that the basic green and red are no longer displaced. It is much more difficult to produce a blue glass which removes the excess red of the lamp without producing an excess green. However, this goal has been neared, and a double apparatus has been constructed which determines measurably the requirements of compensation of any given lamp to chromatic neutrality. Neutral light can be defined as light which is not absolutely fixed in its physical composition but can vary within limits and at the same time can maintain its characteristic physiologic effect, namely, the production of pure brightness adaptation without displacement of the four cardinal points from their primary position in the color circle.

The testing of light for neutrality is of practical importance in all industries which deal with colors and colored materials.

The neutral light filter, or chromosemagraph, is a handy, sensitive, dependable, workable instrument, with varying applicabilities. It serves for testing and producing chromatic neutrality of sources of light and for testing the color sense of normal and of color blind persons; it can be used also for the diagnosis of disturbances in color sense.

DISCUSSION

DR. ALFRED VOGT, Zurich, Switzerland: Were the different composite neutral lights tested for the color after-image phases, and were these after-image phases correspondingly different?

PROF. A. TSCHERMAK-SEYSENEGG, Prague, Czechoslovakia: The after-image course, especially with neutral light of varying composition, is the same in all cases if the same conditions are maintained. The after-reaction is not governed by physical factors (composition and wavelength) but by physiologic factors, which are determined by the free valents of the stimulating light.

A New Method of Testing Performance in Weak Light and of Testing Sensitivity to Glare. Prof. W. Comberg, Rostock.

I have developed a new procedure to be used in examining fliers, automobile drivers and seamen. I have departed from the time-consuming adaptation test and employ an apparatus which was built for me by Zeiss, of Jena. With this apparatus vision is tested in a shorter time after "right" accommodation and after a preceding diminution in light. I started with the assumption that testing the performance immediately after a marked decrease of light corresponds to the most important daily demands and that any deficiencies in adaptation show immediate decrease in performance. Immediately after a marked diminution in light, a test for sensitivity to glare is performed, in which the glaring light corresponds to conditions encountered by the automobile driver. Examination lasts not longer than six minutes and thus is applicable on a large scale, in contrast to the usual adaptation test. Investigations so far have shown, as could be expected, that the usual disturbances in adaptation produce marked deviation and that the immediate performance, in spite of ordinarily good visual acuity, is markedly affected by such conditions as slight corneal haziness or beginning opacity of the lens. No less important is the test with a glaring light, in which the practical disability of the person examined becomes convincingly obvious, in spite of good or only slightly impaired visual acuity.

DISCUSSION

Prof. Friedrich Best, Dresden: I wish to stress the possible importance to automobile drivers of the peripheral as well as the macular adaptation and suggest that both be tested. The present test records only the macular adaptation.

Prof. E. Engelking, Heidelberg: I consider Professor Comberg's apparatus an advance and practical, but because of its prohibitive price I wish to call attention to the fact that fairly accurate and adequate determinations can be made with the scotoptikometer of Möller and Edmund, which is a moderately priced instrument with which one can make a practical estimate of the immediate adaptation within a period of five minutes without the use of a dark room.

Dr. Franz Fischer, Vienna, Austria: I suggest adding a test of the visual fields in decreased light to the other tests.

The Study of Aniseikonia: Review and Outlook. Dr. Werner Herzau, Erfurt.

While investigating motor asymmetry in the action of the two eyes, Ames and Glidden also found sensory incongruences, unequaled imaging, for which they chose the term aniseikonia. To prove and measure such differences in size and contour, they used a haploscopic arrangement, the so-called ophthalmoeikonometer.

Ames and his co-workers have shown the frequent occurrence of a difference in the sizes of the images in the two eyes as an independent anomaly. Whether this condition is based on asymmetry of the refractive media, incongruences in the distribution of the retinal elements or asymmetric reaction to the central organ must be the object of future

research. The statistics of Carleton and Madigan show that aniseikonia may exist independently of anisometropia; that there need not be any connection between refractive and structural equality.

The evaluation of the practical significance of the anomaly is based on 3,000 clinical cases. Pathologic structural equality of 1 per cent and upward may produce characteristic asthenopia and general nervous symptoms in predisposed persons. By correction of the aniseikonia with the enlarging lens, described by Ogle, the optical principle of which was discussed first by Weiss in 1923, relief or improvement of the condition, which had persisted after the correction of refraction and positional anomalies and had been missed in the customary examination of the eye, was brought about in 60 per cent of cases.

Significant are the reports of Bielschowsky, who determined aniseikonia as a cause of lack of fusion. He described the development of a marked difference in the sizes of images in cases of strabismus. Aniseikonia is particularly interesting to the worker in physiology, for only a slight difference in the sizes of images in the two eyes lead to disturbances in orientation. This can be shown by horopter curves. By experiments on myself, I am convinced that by artificially enlarging the image 3 per cent in one eye that the disturbance can be prevented in the presence of adequate points of comparison and fixation but that in their absence, even after days of using corresponding lenses, gross errors in estimating the angle of an inclined plane, such as the shape of a hill, will occur.

DISCUSSION

PROF. A. TSCHERMAK-SEYSENEGG, Prague, Czechoslovakia: I welcome the building of a bridge between American research in aniseikonia and German ophthalmology. I wish to stress the necessity of using dioptric asymmetry to explain the phenomenon of aniseikonia—especially the Herzau-Ogle phenomenon of apparent separation of identical constituents in the haploscope picture at equal distance in association with a symmetric convergence of high degree.

PROF. DR. H. HARTINGER, Jena: From the point of view of the optician, aniseikonia is the same as slight anisometropia. For the last twenty-five years one has been able to give binocular vision to eyes with marked anisometropia, such as occurs after a cataract operation on one side. In the United States errors in the retinal images under 1 per cent are corrected with special types of lenses. This is nothing new, for Weiss at the congress in Jena in 1922 gave a basic solution for this problem, and Erggelet has also contributed to it. I have considerable doubt as to the practical effect of correcting errors of aniseikonia. The Americans calculate these lenses approximately. The results hold good only for vision along the optic axis. Therefore, by diagonal vision such lenses may produce differences in the sizes of the images which may be greater than those which are to be corrected. One must consider that all persons with astigmatism show aniseikonia, since the corresponding visual aids produce different enlargements in the two main axes. Although I do not esteem the practical effect too highly, I have constructed an apparatus for stereoscopic measurements which I shall place at the disposal of Dr. Herzau in the near future.

THE QUESTION OF ACCOMMODATION. PROF. E. SEIDEL, Jena.

I have discovered in the intact human eye that with every exertion of accommodation the diameter of the equator of the lens decreases in all directions; with release of the tension of accommodation, the diameter again increases in all directions. After the instillation of atropine, this change in the diameter does not occur. These facts can be observed easily in the following manner: In the intact completely albinotic human eye which is illuminated by means of an ophthalmoscope, the equator of the lens is seen as a fine black line near the root of the iris, and motion of this line can be observed during the process of accommodation. Helmholz described this phenomenon on the basis of indirect evidence obtained by him and by other observers on examination of injured eyes, of eyes on which iridectomy had been performed and of eyes with congenital absence of the iris (Coccius in 1867, Comberg in 1933 and Grossman and Uhthoff) and on the basis of such evidence in the surviving dissected eye (von Hess). This assumption was rejected as unphysiologic. My observation on the eye in the physiologically intact condition is the first direct observation of this phenomenon and bears out the observations of Ulbrich in 1908, which were checked by Elschnig. It was shown conclusively that under physiologic conditions the equalization of differences in pressure between the anterior and the posterior chamber occurs more easily during the effort of accommodation than during fixation on a distant point. It follows, by necessity, that during accommodation the lens cannot be pushed more closely anteriorly against the iris, but that in contrast it lies more lightly against the posterior surface of the iris than does the lens, which is fixating on a distant point. This fact is in harmony with the observation of von Hess that the lens wavers during accommodation. All these facts speak against the Tscherning-Pflugk theory of accommodation and can be explained by the theory of Helmholz.

MANNER OF DEVELOPMENT OF UNILATERAL AMBLYOPIA. DR. H. HARMS, Berlin.

The mechanism of the development of amblyopia is not clear. I have made new studies which indicate that the inhibitory processes which occur in the presence of strabismus in the interest of clear vision are effective in the retina. On the other hand, it is apparent that a central area of inhibition is necessary. These and other observations justify the assumption of a preformed inhibitory mechanism. The inhibitory impulses arise in the fusion center, above the visual cortex; they are conducted to the periphery by descending pathways and become effective in the ganglion cells of the retina. Constant central inhibition of one eye in the child leads to impaired vision. The inhibition sets in as soon as a considerable difference in the sizes of the images of corresponding retinal areas does not permit fusion of uniform impressions. Such a difference may be produced by positional errors of the eye or optic errors of one eye or of both eyes. The amblyopia associated with anisometropia is therefore an inhibitory amblyopia. This is shown in the individual case by the presence of a central scotoma and a decrease in the pupillomotor index. The practical implication is that unilateral amblyopia can and must be relieved by treatment with exercises.

DISCUSSION

DR. FRITZ WECKERT, Goslar: The central scotoma cannot be considered the chief cause of amblyopia associated with strabismus. There are strongly suspected differences between the central scotoma which is the result of ocular disease and impaired vision due to squint. All areas of perception, and not just the central portion, correspond in the two eyes in the healthy state. A central scotoma only blocks central fixation, the sensory connection of the peripheral fields being preserved in the two eyes; therefore a central scotoma never causes deviation. It is different with amblyopia. Here, because of lack of usage, no points of perception have developed which correspond beyond a rough measure. No relation exists between the right and the left eye. The accidental correspondence of one part of the retina of the divergent eye with a center of fixation of the other eye makes this area of fixation seem something special, and thus there is paracentral fixation with visual acuity greater than that of other areas.

The visual impairment associated with strabismus is reversible at any age if the loss of the leading eye necessitates the use of the other eye. This is important in cases involving compensation, and such cases should be judged on a year to year basis.

DR. FRANZ FISCHER, Vienna, Austria: I feel that the solution of the question of amblyopia associated with squint is closely connected with the question of the causes of squint, and, like Dr. Harms, I do not like to speak of amblyopia of disuse but rather of amblyopia of faulty use.

PROF. BRUNO FLEISCHER, Erlangen: Central scotoma and decreased pupillomotor reaction are not conclusive evidence on which to localize the cause of amblyopia in the retina.

PROF. FRIEDRICH BEST, Dresden: That inhibitory impulses may arise from the retina is indicated by the use of the electroretinogram and by measuring the action potential of the optic nerve in the excised eye. Electric impulses arising from impulses of light can be inhibited by other impulses of light. This might indicate that the retina and the central area of vision are both affected by the inhibition.

DR. H. HARMS, Berlin: If I gave the central scotoma the prominent place in this discussion, it was because it is a characteristic finding in cases of amblyopia. In cases of squint a series of other important factors play a role in the visual processes which have no place in this discussion. The inhibition is not a physical process but a measurable physiologic one. That the retina is affected by the inhibitory impulse is proved by the decrease in central pupillomotor irritability. Similarly, as in hemianopia, one interprets a disturbance in the optic tracts on the basis of the absence of pupillomotor irritability of the blind half of the retina. In the case of transient or permanent scotoma associated with squint, one must conclude from the decrease of central pupillomotor irritability that the disturbance is peripheral to the origin of the ascending light reflex tract. The ganglion cells of the retina are the only cells concerned in this inhibition. One must distinguish between a central conduction area of inhibition which lies above the visual cortex in the

sensory center of fusion and its peripheral point of attack in the retina. I agree with Professor Comberg that inhibition of this type is in agreement with general biologic principles.

The difficulties in demonstrating a central reaction in cases of amblyopia are enhanced by the fact that the scotoma consists of a small stable and a larger labile part. The stable part corresponds to the "blocking," and the labile part, to the impulse of inhibition. The latter disappears when the fixing eye is covered. This explains the inconsistency in the extent and the intensity of the scotoma in perimetric measurements. It further explains that with ocular exercises the improvement in visual acuity is rapid in the beginning, but later is much more gradual. For the same reason, improvement is possible in the adult, the recurrences of amblyopia, which point to the functional character of these lesions, being explained by the absence of organic anatomic changes. The relief of amblyopia is but a step in the treatment of squint, and such treatment can be permanently successful only if the basic cause is removed. Only then can permanent complete functional healing with normal binocular vision be obtained.

THE PROBLEM OF REINFECTION AND SUPERINFECTION OF THE LUNG AND ITS EFFECT ON THE EYES. PROF. E. KRÜCKMANN, Berlin.

A large number of diapositives in which reinfection of the lung was clearly seen and iritis could be demonstrated as a sequelae have been studied. (These were presented.) No clearcut proof is available to explain diseases of the eye in which a superinfection of the lung has to be considered, but further evidence will be presented in a later paper.

TUBERCULOSIS OF THE EYE AND OF THE LUNG AND THE NEGATIVE TUBERCULIN REACTION. PROF. W. ROHRSCHNEIDER, Königsberg.

Four patients with bilateral iridocyclitis associated with nodule formation and precipitation gave a negative cutaneous reaction to tuberculin and showed a peculiar pulmonary picture. Roentgen examination revealed enlargement of the mediastinal glands and a fine, laminated, netlike cloudiness arising from the hilus and extending to the periphery of the middle and lower fields. I consider the condition in these cases to be one of the forms of asymtomatic tuberculosis discussed in the literature by Mylius and Schurmann or universal sclerosing tuberculosis with giant cell hyperplasia or a disseminating type of tuberculosis described by Hantschmann. The complete picture consisted of iridocyclitis, pulmonary changes, a negative tuberculin reaction, enlarged lymph glands and changes in the bone and skin in the form of Boeck's benign miliary lupoids. I wish to stress the importance of the negative tuberculin reaction (Mantoux) in such cases.

TUBERCULOSIS OF THE EYE IN CHILDREN. DR. R. VÖLKEL, Freiberg.

Twelve children with tuberculosis of the eye were observed in an institution over a period of seven months. In 7 cases evidence of exudative lymphatic diathesis was found. These children had hypertrophic pharyngeal and palatine tonsils, palpable cervical glands, a tendency to eczema, enlarged hilus glands, shown roentgenographically, and

impairment of their general physical condition; 2 of the children had general scrofula. The ocular findings consisted predominantly of exudation. With climatic supportive treatment and an increase in weight, 4 of the children were cured and 2 were improved; the process in the eye of 1 child progressed. In the cases in which there were chronic recurrences, the condition in the eye paralleled the changes in the general condition. Recurrences with simultaneous involvement of the affected cervical glands and joints were considered to be due to hematogenous dissemination. The prognosis in these cases should be guarded.

DISCUSSION ON PAPERS BY PROFESSOR KRÜCKMANN, PROFESSOR ROHRSCHNEIDER AND DR. VÖLKEL

PROF. HANS SCHMELZER, Erlangen: Professor Rorhschneider leaves a question as to whether tuberculosis or lymphogranulomatosis was present in his cases. Because the reactions to tuberculin were negative at first, even with low dilutions, but gradually became positive after improvement in the ocular, and the general condition, I presume that the condition was tuberculosis. I believe that the patients were in a state of anergy because of deficiency in the defensive mechanism against tubercle bacilli toxin and therefore gave a negative reaction to tuberculin although progressive healing occurred. The state of anergy changed to a state of allergy, in which injections of tuberculin gave a positive reaction.

PROF. A. PILLAT, Graz, Austria: The list of ocular diseases which are considered tuberculous in the absence of a positive reaction to tuberculin can be lengthened. The ophthalmologist cannot reject a tuberculous causation because of negative Pirquet and Mantoux reactions. One must remember that there are tuberculous diseases in which the Mantoux reaction is negative but the reaction to ektebin is positive, and, further, that the Mantoux reaction, although negative for forty-eight hours, may become positive in eight days. Furthermore, if high dilutions of tuberculin of 1:1,000 to 1:1,000,000 give negative reactions, low dilutions of 1:10 may give positive reactions.

PROF. DR. W. RIEHM, Giessen: I should like to ask Professor Krückmann about the relative frequency of exogenous new infection, or superinfection, to reinfection from an old source. I believe that the former is less likely.

PROF. W. ROHRSCHNEIDER, Königsberg: Presupposing that human tuberculosis is present, three types of anergy may be responsible for a negative tuberculin reaction. Two are similar to the types of anergy seen in association with other allergies. A characteristic of the first type, or negative anergy, is that all antibodies are used up or are blocked. Such an anergy is seen in cases of acute generalized miliary tuberculosis or as a transient phenomenon during measles. This type of anergy is absolute. Any amount of testing solution or any concentration will give a negative reaction. A second type of anergy, so-called positive anergy, is dependent on the fact that such a high degree of allergy has developed that the quantity of allergen used for the test becomes humorally neutralized in toto by the antibodies, which are present in excess. This anergy is only relative, because with increased quantities of allergen

the reaction becomes positive. A pure positive anergy cannot be demonstrated in the tuberculous patient. The third type of anergy consists of desensitization to tuberculin. Old tuberculin is not a true anaphylactogen but an anaphylactogenoid. One must assume that in the tuberculous patient a substance besides antigen and antibodies takes part in the reaction (x substance). This x substance is necessary for the reaction of old tuberculin and antibodies. If the infection is extensive and spreads through the general circulation, adequate x substance is present. If the tuberculous lesion is calcified or encapsulated and more or less isolated from the circulating fluids, the x substance is quickly used up by the testing material and the reaction becomes negative in spite of ample antibodies in the body. This desensitization to tuberculin is absolute; that is, with increasing doses of tuberculin the reaction remains negative because all the available x substance is used at the first test.

PROF. DR. W. RIEHM, Giessen: I am interested to know what quantity of tuberculin Professor Rohrschneider used in his cases.

PROF. HANS LAUBER, Warsaw, Poland: I wish to stress the importance of demonstrating tubercle bacilli in the blood stream. My associate, Dr. Wróblewski, has developed a method with which positive cultures can be obtained in eight days. Most of his patients suspected of having tuberculosis have positive blood cultures, even when they give a negative reaction to the Mantoux test. He makes an autovaccine from these tubercle bacilli and employs it in treatment. The results are good, much better than with tuberculin. Severe ocular tuberculosis is favorably affected. Naturally, attention is paid to the general condition of the patient.

DR. FRITZ WECKERT, Goslar: The hematogenous dissemination is responsible only in part for the occurrence of tuberculous inflammation of the eye. I presume that individual and local predisposition are important etiologic factors. I consider tuberculous iritis as much a manifestation of tuberculosis as lupus erythematosus or lichen scrofulosis, which at times occur simultaneously with tuberculosis of the eye. I feel that failure to find tubercle bacilli in the lesion does not exclude a diagnosis of tuberculosis but that the diagnosis can be made on the structural character of the lesions.

DR. FRITZ FISCHER, Vienna, Austria: I believe that the management of tuberculous iridocyclitis belongs to the ophthalmologist rather than to the internist.

PROF. O. MARCHESANI, Münster: I am of the opinion that constitutional factors are of greatest importance in iridocyclitis. These patients show an allergic hyperactivity which is a congenital predisposition and is not acquired. The manner or reaction in the tissues represents a mesenchymal weakness and is the important factor, not the agent that produces it. The formation of nodules in the eye is not only a characteristic of tuberculosis but also of rheumatic fever, as was shown by Davids' demonstration.

PROF. DR. W. RIEHM, Giessen: The differences in tuberculin reactions may be explained on the basis of unequal distribution of antibodies. I feel that it is unjustified to test the cutaneous sensitivity of a patient with an ocular infection. I believe that a cutaneous test gives an accurate

index only in the case of a tuberculous lesion of the skin. Selection of one organ in preference to another in any given patient depends on a local biologic insufficiency to immunity.

Dr. R. Völkel, Freiberg: The changing picture of the general condition was also observed in adults with ocular tuberculosis, especially in those with severe exudation. However, these conditions are best studied in the child because the reactions are more definite at early ages. As regards the localization of the disease, the anterior portion of the uvea is affected most frequently. Eight of the 12 children had iridocyclitis. It was purely exudative in 2, of the exudative-productive mixed types in 5 and of the productive type in only 1. I found all the transitional forms, contrary to Igersheimer, who considered the nodular process as typical of iridocyclitis in children. Schick, Bergmeister and others have discussed the malignant types of juvenile uveal tuberculosis. These types, the prognosis of which is grave, do occur; but in my experience productive mixed types and even purely exudative types occur more frequently, and their prognosis is considerably better.

Keratoconus. Prof. Marc Amsler, Lausanne, Switzerland.

Thanks to keratophotography, one is able to trace slight degrees of keratoconus and to demonstrate it objectively in pictures. From such pictures one can see as the one pathognomonic sign of the keratocone fruste the angulation of the horizontal axis, which can be measured in degrees.

From a consideration of all cases of keratoconus, which are much more frequent than it is generally assumed, a practical classification into four stages may be made. I have at my disposal a series of 394 pictures, accumulated during the years 1929 to 1938. Of 105 patients, 74 were women and 31 were men. There are 90 cases of bilateral and 50 of unilateral keratoconus. Of the 195 affected eyes, 151 showed mild keratoconus and 44 the severe type. The condition in more than three fourths of all cases is generally not diagnosed, and hence these cases are not included in pathognomonic considerations.

Except for the well known changes in the cases of fully developed keratoconus, the majority of the eyes affected show no progression of the typical distortion.

Although many cases of familial keratoconus are known today, the inheritance of this condition is not proved. All of the literature on keratoconus deals exclusively with the severe type, which makes up only a small fraction of all the cases.

DISCUSSION

Prof. Alfred Vogt, Graz, Austria: I do not believe that the deviation of the angle of the major meridian which Amsler found associated with astigmatism has anything to do with keratoconus. Such a deviation is stationary, while keratoconus is a progressive disease, which stops only after a definite time. Furthermore, the keratoconoid eye has a refractive power of 40 to 60 or more diopters. If Professor Amsler's opinion were right, keratoconus would be even more frequent than he believes, because one finds such deviation quite regularly.

PROF. W. COMBERG, Rostock: In making measurements with the Javal ophthalmometer I have noted patients in whom the axes of the two eyes were not vertical to each other and the corneal picture of the angulations did not seem exactly normal and under certain conditions showed noticeable irregularities.

PROF. MARC AMSLER, Lausanne, Switzerland: Mild keratoconus can be recognized with the ophthalmometer. The observations of Professor Comberg are perfectly true. These characteristics of the keratoconoid eye are familiar to every careful observer.

RELATION BETWEEN MACROCORNEA AND BUPHTHALMOS. PROF. KARL VOM HOFE, Cologne.

Clinical observation has shown that macrocornea in youth may develop into buphthalmos in later life, that buphthalmos and macrocornea may exist in the same person and that macrocornea and buphthalmos may appear alternately in children of the same family. It is thereby proved that macrocornea and buphthalmos are fundamentally the same process and are genetically related.

DISCUSSION

PROF. R. SEEFELDER, Innsbruck, Austria: The concept that macrocornea is purely a developmental anomaly must be maintained; however, increased pressure and hydrophthalmos may be present in an eye with macrocornea. In cases in which there is hydrophthalmos in one eye and macrocornea in the other, a decision as to whether the latter corresponds to a sanative hydrophthalmos cannot be made. Equal enlargement of both corneas without any evidence of stretching, as was pointed out by Kayser, must point toward an anomaly of growth and therefore to a sharp distinction between hydrophthalmos and macrocornea.

PROF. BRUNO FLEISCHER, Erlangen: The literature differentiates between macrocornea and megalocornea. Professor vom Hofe evidently makes no differentiation. It can be demonstrated anatomically that an eye with megalocornea does not show any signs of glaucoma. Further, megalocornea shows a typical recessive sex-linked inheritance, in contrast to the simple recessive inheritance of primary hydrophthalmos; if in some cases glaucoma develops later, it is secondary glaucoma, arising from the disproportion of cornea to lens. Therefore, megalocornea has nothing in common with the causation of hydrophthalmos.

PROF. KARL VOM HOFE, Cologne: Macrocornea and megalocornea are definitely not the same process but are related genetically, because if the picture can change from one to the other or occur simultaneously in the same person or alternately in siblings, as I described, the two conditions cannot be fundamentally different.

PROGRESS IN CORNEAL TRANSPLANTATION. PROF. WALTHER LÖHLEIN, Berlin.

Of 18 eyes in which corneal transplantation was done because of optical indications, 1 eye became blinded to perception of light and had false projection due to a lye burn and secondary glaucoma, and another

eye was lost due to phthisis bulbi. In all other eyes the graft took. In no case was the visual power decreased after the operation; it was unchanged eight times, moderately improved four times and considerably improved five times. The improvement in these 5 cases was as follows: from 1/10 to 4/5, from 1/100 to 4/8, from perception of hand movements at 1 meter to 4/24, from correct projection to 1/24 and from 1/25 to 2/20, respectively. However, even the slightest improvement cannot be underestimated in the practical and psychic value to the patient. With reference to tectonic indications for corneal transplantation, I wish to refer to 2 cases, in which, in spite of all measures, a recurrent corneal fistula repeatedly prevented the patient from working. In 1 case the fistula was due to severe rosacea keratitis and in the other to central necrosis following keratitis disciformis. In both cases the affected area was punched out and a transplant employed, with successful results. A new use for corneal transplantation is as a prophylactic measure in cases of impending damage to the cornea. Such a procedure was used in a case of malignant ulcus serpens; a good take occurred, with vision of 4/24. It was also employed in a case of rapidly progressing acne rosacea keratitis in the only surviving eye; the transplant was substituted for the diseased area, with vision of 1/8. A more extensive procedure was undertaken in a boy whose cornea was almost completely destroyed by an infection due to Bacillus pyocyaneus. In this instance all of the diseased cornea was removed, including the connective tissue ring, and was replaced by cornea obtained at autopsy. The graft survived but became clouded. For the seven months prior to this report the eye was pale, there was no reaction and correct projection was preserved.

I no longer use the lamellar keratoplastic procedure, which I originally described. I almost always use a trephine of 3 to 5 mm. in diameter and utilize the inverted conjunctival flap for fixation, according to the method of Schöler. On the basis of my experiences I consider cornea obtained at autopsy as adequate as living cornea. This is conceivable, since one does not expect a permanent survival of the transplant but a gradual displacement by surrounding tissue. This progresses with less reaction if the individual chemistry of the living tissue produces reaction in the tissue of the host. Such a reaction is shown by the experiments of Salzer. These experiments have induced me to use human cornea which has been fixed in solution of formaldehyde. In 2 cases this type of cornea was as adequate as cornea from autopsy material, and in 1 case in which bilateral transplants were necessary, I used one type of cornea in one eye and the other type in the other and obtained better vision with the cornea that had been fixed in solution of formaldehyde. I advise the use of this type of cornea.

EXTENDED INDICATIONS FOR CORNEAL TRANSPLANTATION. DR. Z. NIŽETIĆ, Belgrade, Yugoslavia.

I believe that the establishment of the fact that the cornea obtained at autopsy is an excellent material for transplantation, even more suitable than that from a living enucleated eye, has opened a new era in corneal surgery. While at first one operated only on the eyes of blind persons, I believe now that the indications for corneal transplantation

can be extended. I have used this method in 6 cases. In 2 cases of ulcers of the cornea operation was done two and three years ago, respectively, with excellent results in visual acuity. In the third case transplantation was done for cosmetic reasons in a young girl with convergent strabismus. In a fourth case I did a plastic transplantation for a perforating vertical corneal scar with attachment to the iris. I freed the attached portion of the iris and obtained improvement in visual acuity. The transplant for use in the fifth case was removed forty hours after death and was used after preservation in cod liver oil for twenty-four hours; the transplant healed cleanly and remained semitransparent. In the sixth case, that of sloughing of the cornea due to ophthalmoblennorrhea, a tectonic keratoplasty was done on both eyes with good results.

DISCUSSION ON PAPERS BY PROFESSOR LÖHLEIN AND DR. NIŽETIĆ

PROF. ANTON ELSCHNIG, Marienbad, Czechoslovakia: Thirty years ago I revived von Hippel's keratoplastic operation and reported the cases in which it was successful. Numerous reports, especially by Ascher and Stanka from my clinic, have included all my cases in which the procedure was done. Best suited for transplantation are corneal scars due to parenchymatous keratitis, which give an almost 100 per cent assurance of success. The worst scars for such an operation are those in glaucomatous eyes and those due to burns from ammonia. I have added tectonic indications to the optical ones. Professor Löhlein has added a prophylactic indication. As regards the implant, it remains without sensation even after a number of years. It must be assumed that it becomes replaced by new growths of corneal tissue. Corneal cells which can regenerate must be present to obtain a transparent healing.

PROF. JOSEF IMRE, Budapest, Hungary: I have had experience with corneal transplantation in 50 cases. In 29 it was done in the hope of improving vision. Definite and permanent improvement was obtained in 15 cases. Since operation was done twice on one of the eyes, 15 of 31 transplants were successful. To date, I have used only corneas of freshly enucleated eyes for transplants. The blood group is no factor. The corresponding maximum size of the transplant seems to be 3 mm. Larger disks cloud more easily. Increased age of the donor gives better chance for clear healing. Old cornea shows less tendency to clouding or edema. Transplantation in cases of clouding after parenchymatous, lymphatic or rosacea keratitis as well as in cases of trachoma offers more hope of success, while transplantation following injuries from caustics is totally unsuccessful. In several cases in my series transplantation was followed by a surprising clearing of the surrounding corneal tissues. The explanation of the high percentage of clear transplants is due to the nutrition of the transplant by the conjunctival flap.

DR. TORSTEN FRIEBERG, Malmö, Sweden: On the basis of experiences in 14 cases, I do not consider the blood group to be a factor.

PROF. RUDOLF SCHNEIDER: I do not consider vitality of the transplant a factor. Thirty years ago Salzer performed transplantation with corneas fixed in solution of formaldehyde.

PROF. WALTER LÖHLEIN, Berlin: Cadavers' corneas are used only if the presence of syphilis can be definitely excluded. Blood groups are

not taken into consideration. There is evidence of the replacement of the transplant in the course of time. Corneas fixed in solution of formaldehyde seem to be as good as living ones.

DR. Z. NIŽETIĆ, Belgrade, Yugoslavia: Originally the cornea obtained at autopsy was used because of necessity, but now such a cornea has become the preferred material.

Demonstration Session

Monday, July 4, 1938

PROF. W. ROHRSCHNEIDER, KÖNIGSBERG, *Chairman*

THE FAMILY TREE OF A FAMILY WITH CONGENITAL CATARACTS. PROF. R. SEEFELDER, Innsbruck, Austria.

In a family emigrating from South Tyrol, 16 members in five consecutive generations had congenital cataracts in contrast to 58 with normal eyes. The cataracts were inherited as a dominant characteristic. Most of the cataracts were of the anterior central capsular type, with clouding of the adjacent lens substance and exemption of the marginal portions. The lenses with cataracts showed a marked tendency to shrinkage. A pure lamellar cataract appeared in 1 person, and a posterior polar cataract in another. The results of operations as regards vision were definitely poor. Most of the persons affected with cataract and most of the other members of the genus were morally inferior, asocial and unable to live a regulated existence, so that they came in frequent conflict with the law. The inheritance of the cataract came from the ancestor, Barbara; the other degenerate tendencies came from her husband, for they also appeared in another line, namely, in the descendants of the brother of the husband, in worse form than in the genus with cataracts.

FIXATION OF THE EYEBALL DURING CYCLODIALYSIS. PROF. R. SEEFELDER, Innsbruck, Austria.

The fixation of the eyeball during cyclodialysis is done by means of hooked forceps at the insertion of the tendon of the exposed external rectus muscle and is therefore simple and dependable. The cut through the sclera is carried just below the line of insertion and at a distance of 6 mm. from the limbus. One is able thereby to detach the whole lateral half of the ciliary body and obtain marked and permanent lowering of pressure. Cyclodialysis must be considered the most dependable operation for glaucoma simplex, and it has given excellent results in other types of glaucoma on many occasions.

DOUBLE SLIT SYSTEM WITH CONSTANT WAVELENGTH FOR MIXED SPECTRAL LIGHT. PROF. A. TSCHERMAK-SEYSENEGG, Prague, Czechoslovakia.

I have devised an apparatus, built by J. J. Fric, of Prague, which makes it possible for one to obtain pairs of spectral lights which strictly

maintain the changes in the width of the slit, or the intensity; in other words, their relative mixtures, or their mean wavelength. This is of value in developing test lights for the examination of color blind persons.

A METHOD FOR EVISCERATION. PROF. E. KRÜCKMANN, Berlin.

The technic of a method for evisceration in which the function of the ocular muscles is well preserved follows: The conjunctiva is divided close to the limbus and is diverted for about 1 cm. Then the tendon insertions of the four rectus muscles are undermined. A silk thread is pulled under the tendons by means of a Peans hemostat, in such a way that the ciliary vessels will not be subjected to pressure when the ends of the thread are pulled together. The ends are tied in a loose knot. The cornea is divided sharply at its margin, and the internal surface of the sclera is scraped clean. The portions of the sclera which lie between the ends of the muscle are removed by a curved incision, so that the inside of the sclera is spread and the remaining rests of the uvea are searched for and completely removed. It is exceedingly important that the segment of sclera which results from this incision be rounded to avoid possible necrosis. A catgut suture is placed before the site of insertion of the vertical and horizontal ocular muscles in such a way that the opposing ones become approximated. These threads are cut short after being tied. The silk thread is also tied tightly, but a loose end of 2 cm. is left. This end remains visible between the conjunctival lips, which are sewed together except for this small hole. The silk thread is removed after one week. This method is not advised in cases of malignant tumor, tuberculosis or marked scarification of the inside of the eye or when sympathetic ophthalmia is suspected.

A NEW DEVICE FOR MEASURING ROTATIONAL DEVIATION. DR. E. HEINSIUS, Kiel.

It is well known that exact correction with glasses and correct position of the glasses do not help some persons with asthenopia because of the latent deviation of the position of the eyes at rest. In all these cases a test for vertical and lateral deviation is easily possible with a known method. Such a test is usually not done because of the lack of an apparatus which can be handled easily. To measure the displacement by a simple and exact procedure, a new device, the Stock phorometer, is attached to the Maddox phorometer. The Stock phorometer can can also be used for the tests usually made with it. One can determine accurately displacements of one-fourth degree. This instrument further makes it possible to measure heterophorias and study cases of strabismus due to paralysis of slight degree, which is difficult if the Maddox cross is employed.

The advantage of the apparatus rests with the ability to determine quickly a latent vertical and lateral deviation as well as a rotational deviation. Since the apparatus is simple to handle, it is suitable for the practicing ophthalmologist. It is of value to the military ophthalmologist in examining artillery observers.

THE AMES "KIPPFELD." DR. WERNER HERZAU, Erfurt.

An apparatus devised by Ames for the visualization of positional changes in aniseikonia was demonstrated.

A NEW FRAME FOR TESTING LENSES AND NEW TESTING LENSES. PROF. DR. H. HARTINGER, Jena.

The new box of testing lenses of Zeiss contains lenses of 15 mm. effective diameter and 37.5 mm. outer diameter. These light and thin glasses can be fitted into all customarily used testing frames. The handles of the lenses are large and therefore are easily recognizable; they are black, with the diopters in red. The cylindric and prismatic lenses are easily differentiated by the different shapes of the handles and different colors of the background of the dioptric classification. The prismatic glasses have two small knobs on the anterior side of the holder. The testing frame is characterized by simple construction and light weight. All movable adjustments are easily seen and handled. Four lens holders are provided for each eye. The lens holder nearest to the eye is made like a pocket in which the spherical lens for adjustments of distance can be placed. In the other three holders, which can be rotated, may be placed a cylindric lens, a spherical lens and finally, according to choice, a prismatic lens, a colored glass and a Maddox cylinder, or, by means of a special contrivance, a telescopic lens.

A NEW OPHTHALMOSCOPE WITHOUT REFLEXES. DR. T. GRAFF, Rathenow.

I have devised a new ophthalmoscope, which coincides in shape and external contour with the usual electric ophthalmoscope, but which is free of reflexes (according to the principle of Thorner). This instrument has been manufactured by Busch, of Rathenow. It differs from the Thorner pocket ophthalmoscope in the flexibility of its use and its magnification of the vertical image to seventeen times, and it surpasses the usual electric ophthalmoscope in its visual field and brightness. It can be utilized for the study of the inverted image.

USE OF THE OPHTHALMOSCOPE FOR TESTING THE SENSE OF LIGHT PERCEPTION IN UNILATERAL DISEASES OF THE EYE. PROF. W. COMBERG, Rostock.

The modern electric hand ophthalmoscope, with the illumination sharply focused on a limited field with uniform brightness, can be utilized for quantitative determinations of the sense of light perception in all cases in which comparison of the diseased eye with the normal eye is possible. Practically, the ophthalmoscope can be utilized for the study of many conditions, especially injuries to the eye.

If the ophthalmoscope is so adjusted that the illuminated area forms a sharply defined circle, the diameter of the illuminated circle is proportional to the distance of the source of light, and the brightness of illumination of this circle is inversely proportional to the square of the distance of the source of light.

The sense of brightness is tested by alternating the illumination of the healthy and of the diseased eye while the patient has the lids closed, the lids thus serving as uniformly diffusing filters. The patient is sufficiently sensitive to changes in the illumination. The light appears equally bright to the two healthy eyes if the source of light is held at equal distance; an increase in the brightness of one-fifth or a decrease of one-third can be detected as definite differences by most persons.

In testing the diseased eye, one proceeds as follows: The distances at which the brightness of the light is subjectively felt to be the same by the healthy and by the diseased eye are determined; if the distance for the healthy eye is the same as that for the diseased eye, the sense of light of the two eyes is equal. If the ratio of the distance for the diseased eye to that of the healthy eye is 1:2, the sense of light of the diseased eye is equal to one-fourth. If the ratio of the distances is 1:4, the sense of light is equal to one-sixteenth. I have utilized this procedure at the clinic in Rostock during the last year and recommend it as useful and practical.

KERATITIS SUPERFICIALIS VORTICOSA. PROF. W. COMBERG, Rostock.

Four patients with superficial keratitis, apparently of a herpetic nature, with a definite vortex figure, whose center lay near the center of the cornea, were observed. (Pictures were presented.) In 2 of the cases the keratitis was infectious and of short duration and appeared in association with a cold. The patients were lying in the same room, preparatory to undergoing an operation for cataract, and the keratitis developed on the following day. In both instances it was acute and superficial, and examination showed radial irregular lines in the cornea which in part were twisted into whorls. The disease disappeared so quickly that the first patient could be operated on in a few days and the other one in two weeks. The keratitis in the other 2 cases was of a chronic nature, and the whorls were more pronounced. In 1 of these cases the whorls were associated with decreased sensibility and appeared in an eye which had previously been the site of herpes zoster. In the second case large central bilateral symmetric whorl formations were seen, which were later associated with a slight recurrence of trachoma. The course in these 2 cases was much more protracted. The whorls in the case of trachoma were still apparent after three months. In 1928 I demonstrated these whorl formations of the cornea at Heidelberg, including those in a case which I had observed since 1923. For the condition in the cases presented here, I suggest the name keratitis superficialis vorticosa.

A DYNAMOMETER. DR. K. C. MÜLLER, DR. A. BRÜNING and DR. HANS SOHR, Berlin.

A new instrument, the dynamometer, which works on the principle of a piston on a spring, embodies the advantages of the instruments of Bailliart and Sobański but avoids the disadvantages of these apparatus. The adjustable tension of the spring makes it possible to measure low pressures in the retinal veins as well as high pressures in the retinal arteries. The frictionless movement of the piston is facilitated

by sliding the piston over two balls. The head of the piston is convex, so that the piston slides off if it deviates from the proper direction of pressure on the eyeball. The average value of the normal diastolic pressure of the retinal arteries is 40 mm. of mercury.

AN INSTRUMENT FOR THE MEASUREMENT OF THE POWER OF THE LIDS. DR. K. C. MÜLLER, DR. H. BRÜNING and DR. HANS SOHR, Berlin.

For the numerical determination of the functional state of the cranial nerves about the eyes, a small apparatus has been devised with which one can determine simply and accurately the strength of the lid closure. The apparatus consists of a type of lid speculum, one arm of which is provided with an indicator, so that the power of the lid closure can be read on a scale showing the tension on the spring of the lid speculum. While there is considerable variation in the eyes of different persons (134 to 209 Gm., with an average of 160 Gm.), the power of the lids in the individual case is equal in the two eyes. This instrument has been found to be of particular value in determining the effect of therapy in cases of myasthenia gravis. By testing the effect of prostigmine on the power of the lids, one can determine whether myasthenia gravis is present and whether an adequate dose of prostigmine is being utilized.

EKTROPIONATOR DESIGNED ACCORDING TO ROSTKOWSKI. DR. J. KLAR, Katowice, Poland.

An instrument has been devised which enables one to evert the upper eyelid completely. It comes in two sizes and is made in one piece. It facilitates total eversion and thus enables one to make a complete examination of the conjunctiva. It is of particular value in the diagnosis and treatment of trachoma. It is also useful in the Blaskovic operation for ptosis and in cases in which the application of Desmarre's lid retractor is impossible.

THE HISTOLOGIC PICTURE OF FRAGMENTARY CORNEAL DYSTROPHY. PROF. DR. MAX BÜCKLERS, Tübingen.

At the International Congress of Ophthalmology in 1936 the appearance of the eye of a 70 year old woman was described. She has since died. Anatomic study of the eyeball, fixed in Zenker's solution and embedded in pyroxylin, showed the following picture: The epithelium was preserved everywhere but thinned in places; Bowman's membrane was degenerating. Amorphous deposits were seen in all layers of the stroma. They stained red with eosin, olive brown with Van Gieson's stain, brilliant red with Pasini's stain and not at all with cresyl violet. These deposits were probably keratohyalin, which was formed at the site of local destruction of the stroma.

IMPROVED X-RAY APPARATUS FOR LOCALIZING FOREIGN BODIES, ACCORDING TO COMBERG. PROF. DR. MAX BÜCKLERS, Tübingen.

An improved x-ray apparatus which seems particularly suitable for the localization of foreign bodies in the eye and adjacent structures, such

as the paranasal sinuses and the sella turcica, has been manufactured by Siemens-Reiniger. It is also useful in locating foreign objects in the distal portions of the extremities.

RARE CHANGES IN THE CORNEA AND SCLERA. PROF. CARL MYLIUS, Hamburg.

Defects covered with connective tissue were observed in the sclera of the nonirritated eye of a patient 55 years old; the patient was suffering from chronic rheumatism with severe changes in the joint. Similar pictures have been seen by van der Hoeve and designated as sclera malacia perforans in association with rheumatic polyarthritis. Rochat designated such a condition as scleritis necroticans associated with acute rheumatism. A year ago the patient had gray jelly-like nodules on the sclera. Histologic study at that time showed them to be granulation tissue which resembled a specific rheumatic nodule. The assumption is justified in this case, in view of negative results of investigations for other disease, that the condition must be a specific rheumatic change.

SCLEROSIS OF THE CHOROIDAL VESSELS. PROF. W. GILBERT, Hamburg.

Compared to primary sclerosis of the blood vessels, sclerosis of a secondary nature has not been adequately studied. The constitutional factors in the development of sclerosis stand so much in the foreground that the other factors, particularly infections, are not adequately considered. Buerger's disease, periarteritis and rheumatic arthritis must be considered inflammatory diseases which run their course as necrosis in the media or as periarteritis or in part as endarteritis. Nodular and focal distribution is a characteristic of secondary sclerosis.

In the choroid, primary and secondary sclerosis can be differentiated. Sclerosis of the circulus arteriosus halleri as a precursor to halo senilis is an example of primary disease. Constitutional weakness and increased demand may produce sclerosis of the myopic fundus, while familial hereditary tendencies chiefly explain rare juvenile sclerosis.

The focal appearance of secondary sclerosis is observed in cases of tuberculosis and after acute infectious diseases, like pneumonia and rheumatic fever.

Histologically, sclerosis of the uveal vessels, like that of the small vessels in other organs, is primarily a process of hyalinosis rather than one of lipoidosis. The latter process is particularly noted in cases of nephritis in contrast to calcinosis, which is rarely seen.

RHEUMATIC UVEITIS. PROF. O. MARCHESANI, Münster.

Study of a number of cases of chronic uveitis showed changes in the uvea, sclera and retina which were characteristic of so-called rheumatic tissue damage. In the beginning stages the connective tissue showed focal fibrinoid swelling and later nodules of cells, composed predominantly of large, frequently multinuclear, histiocytes with basophilic protoplasm. Finally, the foci changed to connective tissue scars. True giant cells frequently showed inclusions of fragments of connective tissue which had undergone hyaline degeneration. In the sclera, the rheumatic granulomas were small and spindle shaped and were situated between the lamellae. In the uvea they were larger and round. In the retina granulomas were found in the walls of the vessels or beside the

vessels. In contrast to tuberculosis, these granulomas produce little reaction in the tissue, much connective tissue formation and no caseation. The changes in rheumatism are conceived, in agreement with Klinge, as an allergic hyperergic inflammation.

This type of reaction calls for hereditary, constitutional, mesenchymal weakness as a basis. Two of the patients in my series were cousins, and the morphologic reaction in each was the same.

PERIFOCAL INFLAMMATION IN TUBERCULOUS EYE. DR. EDWARD WERDENBERG, Davos-Platz, Switzerland.

Different symptoms in the composite picture of ocular tuberculosis and also in the eye itself can be of great importance in judging the character of tuberculosis of the eye. In this connection, I wish to call attention to perifocal inflammation of the cornea, iris and chorioretina.

The simultaneous involvement of the cornea in tuberculous cyclitis and iridocyclitis in the form of perifocal exudates about the precipitates, diffuse clouding in the zone of precipitation and deeper infiltration and nodule formation are expressions of severe toxic action during the secondary allergic stage. Such a condition is prognostically unfavorable. A perifocal inflammation in tuberculosis of the iris shows itself in a diffuse resorbable exudate about the iris tubercle. Foci of choroiditis may indicate toxic metastasis of an exudative retinitis. After resorption, there remain a few small choroidal foci.

These toxic inflammatory processes in the eye correspond to the perifocal inflammatory processes of intrathoracic tuberculosis and must be treated with great caution.

NODULE FORMATION IN THE EYE. DR. H. DAVIDS JR., Münster.

Formerly it was believed that nodule-forming processes in the tissues could be attributed to only a few specific causative agents. Pathologic anatomic studies, however, have shown that numerous specific and nonspecific causes may be found. In a large series of material, eight types of inflammatory nodule formation were demonstrated. These included true tubercles, granulomas associated with sympathetic ophthalmia, granulomas associated with rheumatism, granulomas due to metastatic ophthalmia, lymph follicles with germinal centers associated with nonspecific detachment of the iris and nodular aggregates of lymphocytes associated with herpes iritis. The tendency is to consider such nodules as tuberculous because of their location. Caution in diagnosis is indicated.

CELLULAR FINDINGS IN HAY FEVER. PROF. WILHELM GRÜTER, Marburg.

Inflammation of the cornea and conjunctiva in cases of spring hay fever, as studied in vivo, corresponds to the defense reactions seen in cases of trachoma and of other diseases. No microcellular findings which could be considered as unusual or specific were noted.

HISTOLOGIC CHANGES IN HERPES ZOSTER OPHTHALMICUS. DR. W. KREIBIG, Frankfurt on the Main.

The eyes of a 68 year old man who had herpes zoster ophthalmicus on the left side and seven days later generalized zoster showed fresh

changes in the course of the disease. Numerous small vesicles appeared in the conjunctivas. At the same time, fresh fine precipitates could be observed. Two days later, nine days after the onset of the disease, the patient died.

Histologically, there were found numerous submucous pustules in the conjunctivas. The iris of the left eye showed two small foci of necrosis and a thick, demarcating inflammatory infiltrate. The posterior ciliary nerves also showed severe changes. Perineuritis and small hemorrhages and infiltrations lay within the nerve. Small infiltrated nerve bundles could be traced to the ciliary body in the region of entrance of the optic nerve. Numerous perivascular infiltrates also could be seen which were not connected with nerve fibers.

The gasserian ganglion was slightly inflamed on either side. The ganglion cells showed a granular degeneration of the protoplasm throughout, with shrinking of the nuclei.

The severe changes in the periphery were in contrast to the lesser changes in the gasserian ganglion and indicate that the disease first appeared in the skin and uvea and then progressed centrally.

MICROSCOPIC APPEARANCE OF ORBITAL TUMORS ARISING FROM FISSURES. DR. E. SCHRECK, Heidelberg.

The new field of orbital tumors arising in fissures include those tumors which arise from germinal rests which are transplanted during the closure of primitive tissue clefts, such as the more or less mature meningiomas, hemangiomas, branchiogenic carcinomas and epidermoid cysts.

The immature malignant types of meningioma, which heretofore have been classified as different types of carcinoma, are, on the basis of morphologic and genetic findings, neuroectodermal derivatives, and are thus fundamentally different from the carcinomas of mesenchymal origin. The difference between a sarcoma and a mature meningioma of the orbit will be considered first: The sarcoma is characterized by a homogeneous cell arrangement and form and the mature meningioma by systematized, mature neuroepithelial cell formation with a characteristic tendency to lamination and hyaline formation and finally to psammoma granule formation.

In the more immature type of orbital meningioma, that is, the neuroepithelioma, the rapid growth no longer allows the formation of hyaline or psammoma granules but only the formation of laminated cell bodies, so that a somewhat wild, rapidly growing neuroepithelial formation comes to the foreground. A more benign subform is characterized by regularly laminated cell bodies and relatively mature neuroepithelial strands, while a malignant form is characterized by irregular lamination in the form of cell whorls, a picture that has been designated previously as a fibrocellular or spindle cell carcinoma.

The most immature form of the orbital meningioma is the malignant neuroblastoma, which consists of two types: the first, the fibroblastic type, with long fiber-forming meningeal cells, and the second, the primitive epithelial type, heretofore designated as round cell carcinoma, with a tendency toward cell arrangement in circles and rosettes with large tigroid granular neuroepithelial cells and a xanthomatous degenerating portion.

The second group of orbital tumors arising from fissures, the hemangiomas, which are predominantly located behind the orbit, arise from vascular rests which have become separated from the primitive eye anlage.

The third group, the branchogenic carcinomas, are derived from transplanted rests of the primitive gill pouches. They are characterized by infiltrating, moderately undifferentiated, squamous epithelial or basal cell formation in hyalinized, mucoid, cartilaginous or cystically transformed stroma.

The tumors designated as dermoids are epidermoid cysts, which have their origin in skin rests which have been transplanted.

MULTIPLE NEURINOMAS WITH INVOLVEMENT OF THE PAPILLAE. DR. M. SCHMIDT, Königsberg.

A youth of 16 years had marked prominence of the papillae, without loss of function, for three years. In addition, numerous symptoms were present, such as facial paralysis, deafness, flaccid paralysis of the legs and a vestibular apparatus which could not be stimulated. Clinically and roentgenographically, there were no signs of intracranial pressure. Two nodules removed from the neck for biopsy were typical neuromas. Thus the condition is a rare type of Recklinghausen disease with multiple neuromas involving the acoustic nerves, the cutaneous nerves of the neck and the roots of the spinal nerves, with probably a corresponding tumor-like change in the optic nerve near the eyeball.

CHEMICAL FINDINGS IN PSEUDOSCLEROSIS. PROF. RUDOLF THIEL, Frankfurt on the Main, and DR. W. GERLACH, Jena.

The question of the chemical nature of the Kayser-Fleischer ring was somewhat clarified by the researches which Fleischer and Rohrschneider carried on in collaboration with one of us (Gerlach). It was determined by spectographic investigation that no silver was present in cases of pseudosclerosis. These findings are contrary to those of Vogt. Copper was found in the cornea affected with pseudosclerosis. The significance of this was not understood until systematic studies on the normal copper content of the eye could be made. In 1934 one of us (Thiel) presented an interesting case of sunflower cataract associated with hepatolenticular degeneration in which quantitative determinations of the silver and copper contents were made by the same spectographic method. The findings were as follows: Silver was present in the area of pseudosclerosis, though there was no history of medication with a silver compound. A high concentration of copper was found in the anterior portion of the eyeball, which contained the Kayser-Fleischer ring. There was little copper in the liver, but in contrast there were great quantities in the kidney and in the brain.

THE QUESTION OF THE DEPENDENCE OF A TAPETORETINAL DISEASE ON THE HYPOPHYSIS. DR. KARL VELHAGEN, Halle.

Dysfunction of the hypophysis is not necessarily responsible for tapetoretinal degeneration. In a case which I have previously described

and in a new one, the fundus pictures are similar, namely, a peculiar focal tapetoretinal cystic degeneration. The patient in the new case was a woman with mild diabetes insipidus in whom Simmond's cachexia was suspected. The fundus findings consisted of aggregates of slightly pigmented granules. The picture was somewhere between the so-called pepper and salt fundus and retinitis pigmentosa. The visual field was slightly narrowed concentrically.

A Rare Retinal Disease as Part of the Picture of a Systemic Disease of Hereditary Origin. Prof. E. Seidel, Jena.

A patient presented cystic retinal tumors in both eyes associated with nevi of the external skin and hypertrophy of the sebaceous glands of the face. On the basis of the ocular findings, a diagnosis of tuberous sclerosis of the brain was made, although idiocy and convulsions were not present. Van der Hoeve has made important investigations along this line.

A Rare Syphilitic Disease of the Retina (Bilateral Gumma of the Retina). Prof. E. Sidel, Jena.

A man, aged 28, showed an extensive tumor formation in the choroid of each eye. In the right eye, 2 disk diameters from the papillary border, was a tumor 2 mm. wide and 5 mm. long, with a corresponding defect in the visual field; in the left eye the tumor was above the papillary border. It measured 4 mm. wide and 4 mm. long. The defect in the visual field was in the lower temporal quadrant. The appearance of the retinal vessels pointed to syphilis. The Wassermann reaction was negative, but the patient had had a positive reaction at a previous time. He had been given arsphenamine, but the present treatment consisted of the use of mercury preparations and large doses of iodine. Marked regression of the tumors occurred.

(Colored pictures and photographs of the ocular fundi at different stages of the treatment as well as the accompanying visual fields were presented.)

Congenital Avascularity of the Retina. Dr. F. Hollwich, Munich.

Unilateral congenital absence of the retinal vessels was observed in a 6 year old girl. From the stump of the obliterated hyaloid artery, numerous short, fine white strands radiated and coursed through the vitreous to the avascular retina. There was no evidence of inflammatory change, the pupil being fixed. All other findings, including those in the other eye, were normal. The anomaly was assumed to be congenital.

A Contribution to the Question of Direct Trauma and Retinal Detachment. Dr. Rolf Schmidt, Freiburg.

A young man received a light blow to the eye, which resulted in slight injury to the conjunctiva, edema of the retina and a tear, with

subsequent detachment. An operation was performed, and healing took place. I wish to stress the fact that a minor injury may produce retinal detachment.

ATTEMPTED RADICAL RELEASE OF THE ORBIT IN A CASE OF THREATENING EXOPHTHALMOS. DR. R. BRAUN, Rostock.

A woman aged 37 had progressive bilateral exophthalmos with little increase in the basal metabolic rate. Medical treatment was refused. Changes suddenly developed in the cornea, and local treatment proved ineffective. As a last resort, extensive trephining was done from the temporal side without injury to the dura, and part of the orbital roof on each side was resected. The procedure had no effect on the left eye, and only slight improvement occurred in the right eye, so slight in fact that closure of the lids was not effected. For that reason, a large segment of the temporal orbital wall was resected. After that the lids could be passively closed. Sympathectomy on the right side, done a few days later, did not improve the condition. The disease progressed and led to the loss of both corneas. I feel that these radical procedures may be indicated and should be used as prophylactic measures, although in my case they were unsuccessful.

PATHOLOGIC CHANGES IN THE EYES OF RATS IRRADIATED WITH ULTRAVIOLET RAYS. DR. WALTHER REICHLING, Berlin.

Irradiation of the eyes of rats with ultraviolet rays produced the following changes: 1. After twenty-four hours of irradiation edema of the cornea with superficial loss of substance could be determined by slit lamp examination. The edema affected all layers of the cornea which were exposed between the lids. 2. Vascularization and central necrosis of the cornea occurred, giving the effect of sugar coating, as long as no sequestrums were formed. 3. Following the stage of "sugar coating," there was a "raspberry" stage. This consisted of marked vascularization in which some portions of the vessels became markedly enlarged, leading to extensive hemorrhages. Histologically, this change indicates beginning tumor growth. 4. The final stage was that of true tumor formation.

The first stage of corneal edema showed histologically a zone of polymorphonuclear leukocytes just below the corneal epithelium. In the "sugar coating" stage there existed marked transudation of the corneal stroma with the fluid rich in albumin. The corneal epithelium showed marked proliferation, and there was focal destruction of the epithelium and the formation of a membrane. There were numerous giant cells during the "raspberry" stage, and the tumor had the character of a regular, markedly vascular granulation tissue with cellular infiltrates (polymorphonuclears, lymphocytes, plasma cells and occasionally giant cells). In the stage of true tumor formation, a mixed sarcoma was seen histologically. The development of such tumors was more rapid in white rats than in gray ones. Further interesting findings were: (1) exudation in the anterior chamber and ciliary body; (2) deposits of pigment in the corneas of gray rats, particularly along the ingrowing vessels (the pigment may appear rapidly); (3) severe chemosis of the

conjunctiva with dilatations of the vessels and hyperemia, and (4) tumor formation of the eyelids.

BILATERAL INFLAMMATORY EXOPHTHALMOS IN SEPSIS LENTA. PROF. HERMANN SERR, Jena.

Exophthalmos developed in the right eye of a 53 year old man in the spring of 1935. A Krönlein operation performed at that time showed nothing of a suspected tumor. In November 1935, exophthalmos developed in the left eye. On the patient's admission to the hospital in December 1935, marked bilateral exophthalmos with severe chemosis of the bulbar conjunctiva and bilateral corneal ulcerations were present. Thrombosis of the cavernous sinus or orbital veins was suspected but was not verified. The patient's general condition was good except for a cardiac circulatory insufficiency, and there was no fever or splenic enlargement. In spite of all preventive measures, there occurred wide perforation of the corneal ulcer in the right eye and rupture of the left cornea with spontaneous extrusion of the lens. Four weeks after the patient's admission a septic fever suddenly developed, followed by purulent thrombophlebitis of the left saphenous vein, abscess formation on the left ankle and a gluteal abscess. Apparently a septicopyemia was present. An accident two and one-half years previously, followed by peritonitis, was suspected as the etiologic factor. Surprisingly, the patient recovered fully, except for the consequences of the corneal ulcerations. The exophthalmos and chemosis regressed completely.

Second Scientific Session

Tuesday, July 5, 1938

DR. J. W. NORDENSON, STOCKHOLM, SWEDEN, *Chairman*

PROGRESS IN FITTING ZEISS CONTACT LENS. PROF. HERMANN SERR, Jena.

For eyes that cannot be fitted by standard contact glasses, I make casts of the eyes after the method of Dallos. From these casts, Zeiss makes contact glasses the haptic portion of which exactly fits the living eye but the corneal portion of which is ground to obtain the optical correction. I have been able to provide glasses in this manner for many patients who otherwise could not get a suitable fit, and I feel that progress has been made by this method.

DISCUSSION

PROF. C. H. SATTLER, Königsberg: Since 1934 I have been making casts from the living eye after the method of Dallos and have found that in the cases in which this method is employed in the fitting of glasses the untoward effects of epithelial clouding, which sometimes are associated with the wearing of contact lenses, never occur.

PROF. KARL LINDNER, Vienna, Austria: I employ the same method and find it a great advantage. At times I grind away minor defects which are found after the lenses are worn twelve to fourteen days; the defects are determined by slit lamp examinations.

PROF. HERMANN SERR, Jena: I wish to point out the time-consuming element in the fitting of these glasses. It is necessary for the patient to stay in the ophthalmic clinic for eight to twelve days.

THE CLINICAL ASPECT AND PATHOLOGIC ANATOMY OF ORBITAL TUMORS. DR. E. SCHRECK, Heidelberg.

The object of my investigation was to scrutinize the clinical concept of orbital tumors, to classify them on a histologic basis, to determine their relative frequency, to distinguish the relation between anatomic types of tumors and clinical manifestations and to facilitate diagnosis. My study is based on 259 orbital tumors observed between 1900 and 1937 in the ophthalmic clinic at the University of Heidelberg. The tumors were divided into two groups, those which had been operated on (190) and those which had not been subjected to operation (69), and the primary tumors were separated from the secondary growths. There was a numerical gradient of frequency among the primary tumors which had been operated on, with the less mature neuroectodermal tumors (neuroblastomas, neuroepitheliomas and a meningioma) comprising the peak; these were followed by hemangiomas, pseudotumors, sarcomas, carcinomas, orbital cysts, optic tumors and rare osteomas, neuronomas and teratomas. With reference to the gradient of frequency of the secondary tumors which had been operated on, the tumors arising secondarily to processes in the paranasal sinuses, consisting of mucoceles and pneumoceles and an osteoma, a carcinoma and a sarcoma, comprised the peak. Next followed carcinomas of the lid, melanocystoblastomas of the choroid, nevocarcinomas of the conjunctiva and retinal gliomas. Least frequent in this group were the orbital metastases of the breast and genital carcinomas. A third group was then formed from the primary and the secondary orbital tumors which were operated on, consisting of tumors which involved the lid and the orbit simultaneously. This group consisted of 62 epidermoid cysts and a plexiform neuroma, a hemangioma and a sarcoma. In the group of primary orbital tumors which had not been operated on there were 23 pseudotumors (10 inflammatory growths—5 syphilomas, 2 tuberculomas, etc.—8 growths suspected of being inflammatory and other rare conditions). There were also tumors arising secondarily to processes in the paranasal sinuses, carcinomas of lids, tumors of the hypophysis, metastases (4 from a growth in the breast and 1 from a carcinoma of the small bowel) and finally a chronic inflammatory pseudotumor due to actinomycosis. I further grouped these tumors on the basis of the incidence in the different sex and age groups and the dominant symptoms and was able to arrive at certain characteristics, peculiar to, and consistently associated with, the different types of tumors, which are of practical significance in diagnosis and prognosis.

DIAGNOSIS OF VASCULAR ANOMALIES AND TUMORS IN THE ORBITAL FOSSAE AND THE MIDDLE CRANIAL FOSSAE. PROF. RUDOLF THIEL, Frankfort on the Main.

Retrobulbar and retro-orbital tumors can usually be accurately localized on the basis of the clinical findings. But some questions cannot

be answered completely on this basis, especially the problem of therapy. Tumors like the melanosarcoma are refractive to irradiation, and others like carcinomatous metastases are favorably affected. Roentgen studies frequently give a false impression of the size of the tumor.

It would be a definite advance to have a method by which the tumor could be sharply localized and its size and nature determined. The meningioma of the sphenoid sinus, which is one of the most difficult tumors in the orbital region to diagnose, is characterized by marked vascularization. With this in mind, I have used arteriography as a diagnostic aid. The importance of this method in diagnosing vascular anomalies is well established.

The significance of this procedure is demonstrated in 3 cases of pathologic processes within the orbit and the middle cranial fossa.

CASE 1.—In a man aged 61 hemorrhage suddenly developed in the orbit, as evidenced by hemorrhage in the conjunctiva, exophthalmos, disturbances in motility, hemorrhage in the retina and secondary glaucoma. This was considered to be due to arteriosclerotic damage to a wall of the vessel. By means of an arteriogram, a markedly abnormally dilated ophthalmic artery was demonstrated, and the presence of a retrobulbar tumor was definitely excluded.

CASE 2.—Arteriography made possible the diagnosis of a meningioma of the small wing of the sphenoid bone in a man 24 years of age; this was verified by operation and by histologic examination.

CASE 3.—In a 13 year old boy, in the course of a year, ophthalmoplegia and protrusion of the right eye gradually developed. This aroused suspicion of a tumor in the middle cranial fossa. An arteriogram demonstrated that the internal carotid artery was completely obliterated by external pressure at the base of the skull on the affected side. Another arteriogram demonstrated on the left healthy side marked development of the collateral circulation, which indicated the slow development of the condition which interfered with the circulation.

It is more difficult to demonstrate roentgenographically a tumor of the orbit which is relatively avascular. It is known that the roentgenogram demonstrates an intraorbital tumor only if there are changes in the bony orbital wall. The tumor itself rarely casts a shadow.

Since intraorbital tumors usually are surrounded by a dense capsule, an attempt to outline the contour of the tumor by the injection of a contrast medium into the orbit seems indicated. It appears probable that the contrast medium would readily surround the tumor by diffusing through the loose retrobulbar tissue. If these assumptions are correct, roentgenograms taken at planes perpendicular to each other should give an accurate outline of the tumor. Actual trial of this procedure has proved successful.

A woman 37 years old had over a period of twelve years undergone repeated operations on the paranasal sinuses because of atrophy of the optic nerve, congested papillae and increasing exophthalmos. By means of an arteriogram, the presence of a tumor in the middle cranial fossa was definitely excluded. By means of an orbitogram with the injection of colloidal thorium dioxide, a tumor was demonstrated directly behind the eyeball. This was removed by the Krönlein operation. Histologically, examination demonstrated a meningioma of the sheath of the optic nerve.

GLIOMAS IN THE AREA OF THE OPTIC RADIATION, WITH SPECIAL CONSIDERATION OF ARTERIOGRAPHY. DR. T. RIECHERT, Frankfort on the Main.

Operation was performed in 19 cases of glioma in the area of the optic radiation. The optic radiation in general is relatively insensitive to direct pressure and tumor processes, and therefore homonymous defects of the visual field serve as localizing symptoms, which in the absence of other symptoms, particularly of a tumor on the right side, are of particular importance. Various indications exist for the different methods of ventriculography and arteriography and their diagnostic possibilities, especially with regard to the type of tumor.

DISCUSSIONS OF PAPERS BY DR. SCHRECK, PROFESSOR THIEL AND DR. RIECHERT

PROF. A. FUCHS, Vienna, Austria: I wish to issue a warning against the use of the expression orbital tumor in cases of inflammation. There are definitely syphilitic inflammations in the orbit with exophthalmos which give negative serologic indications of syphilis. I saw a patient with bilateral exophthalmos and negative findings in the cerebrospinal fluid who finally died of syphilitic meningitis.

PROF. W. WEGNER, Freiburg: I admit that there are advances in diagnostic facilities offered by arteriography, but contrast mediums should not be used indiscriminately, particularly substances such as thorium dioxide. Fifteen years ago I injected thorium dioxide into the surrounding tissues in an attempt to visualize the lacrimal sac. This at first apparently harmless accident had serious consequences. A tough granulation tumor developed, which filled the orbit and pushed the eyeball forward and fixed it. Roentgenograms showed that thorium dioxide injected into the tissues ten years previously was there unchanged. Thorium dioxide is not absorbed by the organism and may after years produce disagreeable reactions in the tissue. I suggest animal experimentation before this substance is used more extensively clinically.

PROF. H. ERGGELET, Göttingen: I believe that the untoward effects described by Professor Wegner were due to the solvent used and not to the thorium dioxide. This recalls experiences with injections of paraffin in the lower eyelids in cases of entropion and of ectropion. In a case in which a salve containing boric acid was injected into the lacrimal duct marked fibrosis occurred. In the case of Professor Wegner, it is evident that the thorium dioxide was not absorbed, because the patient did not suffer any generalized symptoms such as occur when this medium is absorbed, for it is a toxic agent.

PROF. W. GILBERT, Hamburg: I wish to warn against the indiscriminate use of encephalography and ventriculography as a diagnostic procedure. In the hands of the trained neurosurgeon encephalography still carries a mortality of 5 per cent.

PROF. O. MARCHESANI, Münster: I take exception to the assumption that arteriography is dangerous. In my experience there never occurred an untoward incident or a fatal outcome. In 1 of 2 cases of aneurysm of the carotid artery the aneurysm was beautifully visualized in the arteriogram, but in the second case it could not be demonstrated. It was later shown on surgical exploration. Only positive results are

important in the arteriogram, but a negative picture does not exclude the presence of a lesion.

PROF. ADOLF JESS, Leipzig: In a case of angioma of the face and the brain arteriography proved fatal. This procedure should not be used in cases of such extensive involvement.

PROF. RUDOLF THIEL, Frankfort on the Main: Reference to the literature justifies the use and proves the safety of arteriography.

SARCOMA OF THE CHOROID AND TRAUMA. DR. W. KREIBIG, Frankfurt on the Main.

After the concept of the so-called irritation tumors and of the regenerative tumors was explained, 2 cases of carcinoma of the lid were reported in which a traumatic origin was likely.

The traumatic origin of a uveal tumor is more difficult to evaluate, as it never can be definitely excluded that trauma and tumor are coincidental.

A few cases were discussed from the point of view of the possibility of a traumatic origin of sarcoma of the choroid. The generally accepted opinion that a long latent period exists between trauma and tumor formation is erroneous on the bases of these cases. The criteria set down by Junius, according to which a tumor can be considered as originating after trauma, must be modified, so that a latent period of many years' duration may occur and, further, an injury to an eye may lead to tumor formation at a different place in the uveal tract.

DIATHERMIC TREATMENT OF EARLY TUMORS OF THE CHOROID. PROF. HANS LAUBER, Warsaw, Poland.

In a case of a small sarcoma of the choroid in the immediate vicinity of the macula, therapy similar to that used for retinal detachment was employed. The tumor was touched with a diathermy needle, but retinal hemorrhage prevented continuance of the procedure. The portion of the tumor nearest to the macula was destroyed. The uninjured portion enlarged, and new retinal hemorrhages occurred. The eye was therefore removed five and a half months later. Microscopic examination showed a spindle cell sarcoma, which was completely destroyed at the site of the operation and was replaced by scar tissue. This case proves the possibility of success with this treatment.

DISCUSSION ON PAPERS BY DR. KREIBIG AND PROFESSOR LAUBER

PROF. ADOLF JESS, Leipzig: Diathermy has possibilities, but harmful sequelae, such as hemorrhages and extension of the tumor, may occur.

PROF. KARL LINDNER, Vienna, Austria: I should like to mention the case of Professor Lauber's in which operation was done for melanosarcoma of the ciliary body, and a local recurrence occurred eighteen months later. In another case of flat melanosarcoma electrocoagulation was attempted, but because of incomplete destruction of the tumor the eye had to be enucleated later.

PROF. W. GILBERT, Hamburg: I feel that the relation between trauma and malignant tumors can be considered only if the injury produces a long irritative reaction. Coexistence of trauma and malignant

tumors as accidental associations is very likely. If irradiation of malignant ocular tumors is successful in destroying the tumor, loss of vision occurs, and therefore I see little justification in this method.

PROF. WALTER LÖHLEIN, Berlin: There are theoretic considerations as to the possible mechanism of malignant tumors developing secondary to trauma. In a case of conglomerate tubercle of the choroid good scarification was obtained after treatment with diathermy.

DR. WALTHER REICHLING, Berlin: My experimental results of tumor formation secondary to ultraviolet irradiation of the corneas in rats are examples of chronic irritation leading to malignant tumor. I wonder as to the possibility of similar reactions occurring in other portions of the eye.

PROF. RUDOLF THIEL, Frankfort on the Main: Diathermic destruction of small intraocular tumors is justified, although in general I agree with Professor Jess in advocating restricted use of radiation therapy of orbital tumors. I feel that metastatic carcinoma in the eye from other parts of the body might be an indication for radiation therapy.

PROF. A. WAGENMANN, Heidelberg: Sarcoma of the choroid is the most malignant tumor that is known. I feel that immediate enucleation is the only therapy for this type of tumor and that local treatment is definitely contraindicated.

PROF. HANS LAUBER, Warsaw, Poland: A carcinoma developed secondary to trauma in an 18 year old youth. At the age of 4 he had received radium irradiation to the upper eyelid because of a congenital hemangioma, with the subsequent growth of a basal cell carcinoma.

DR. FISCHER: Sarcomas of the choroid should not be tested conservatively.

DR. FELIX JENDRALSKI, Gleiwitz: I too wish to issue a warning against conservative surgical treatment of malignant conditions in the eye and to call attention to the difficulties encountered at secondary radical surgical procedures if they are preceded by local restricted attempts to remove the lesion.

DR. W. KREIBIG, Frankfort on the Main: A large number of sarcomas are classified under the term irritation tumor; therefore, the desired differentiation of carcinoma and sarcoma on the basis of this criterion is not desirable.

IS THE CHALAZION LIPOGRANULOMATOSIS? PROF. A. FUCHS, Vienna, Austria.

According to the theory of Schall, the chalazion represents a lipogranulomatosis. It is the reaction product in the tissues of fat excreted by the meibomian glands. Definite lipogranulomatosis was found on histologic examination in 2 cases in which there were no previous clinical indications of a chalazion. Epithelial cells and connective tissue had formed about particles of fat, but the typical loose chalazion tissue was not present. The tissue of the fresh chalazion (three to ten days' duration) looks different from that of the chronic type. In the latter type large masses of eosinophils with large granules and vacuolar nuclei are found. These are not present in the later stages. Further, the chalazion does not always originate about the glands of the tarsus

but frequently develops in front of them and even before the cilia at the free margin of the lid. This speaks against the theory of Schall. In my cases the fat was not found in the cavities characteristic for chalazion but was finely distributed in a large number of small droplets and even within the cells. I consider such a picture indicative of fatty degeneration.

In conclusion, I reject the theory of lipogranulomatosis. The characteristic structure of the chalazion tissue, as well as the beginning stages, with the masses of lymphocytes, plasma cells and eosinophils, speaks against this simple explanation. It is definitely not proved that the chalazion always begins in the tarsus near the glands. Attempts to transplant chalazion in animals by injection of emulsions into the lids of rabbits and monkeys have not been unsuccessful.

DISCUSSION

PROF. A. PILLAT, Graz, Austria: I consider chalazion as a clinical concept which covers many diseases with varying histologic pictures and causation. There are the multiple chalazions which appear after one to three days of true vitamin A deficiency, and which are based on the occlusion of the excretory ducts of the meibomiam glands by hyperkeratosis. This occlusion is accompanied by transition of the secretory epithelium in the gland into a more specific epithelium.

PATHOGENESIS OF HERPES OPHTHALMICUS. DR. WILHELM GRÜTER, Marburg.

Two questions arise in regard to corneal herpes. 1. How can it be explained that in microscopic sections the widely dilated tissue spaces show no demonstrable stainable content? 2. What is the fate of the fine elementary granules which I consider secretory granules?

In answer to the first question, dark field and light field examination show that the apparently free spaces in the tissues contain numerous bubbles of gas. These develop secondary to an unusual metabolism in the herpetic cellular inflammation. In answer to the second question, in the surviving epithelial tissue preparation a migration of the secretory granules in the tissue spaces and lymph channels can be demonstrated. The granules migrate passively like cocci and accumulate, stasis of plasma being occasioned by mechanical or by other reasons. In the microscopic section one finds a marked herpetic inflammation inside the lymph cells, as in the nerve, in the form of a pronounced eosinophilic precipitate. From a biochemical point of view, a cell virus is a ferment-like toxin, which on entrance into the living cell gives to the secretory granule a pathogenic character. Thus these granules become the carriers of the unknown virus and transport it through the tissue spaces. The nerve serves as a guide and becomes secondarily infected.

On the basis of this concept, infection of the central nervous system and of the general circulation is brought about by the metastatic transportation of the virus in the infected secretory granules to the different tissues. Thus the appearance of disseminated metastatic foci can be explained easily.

I consider herpes virus as a pathogenic protein-destroying ferment with unusual fermentation characteristics. The virus of trachoma has a similar effect on the secretory granules. (This aspect of the subject

was presented at the fifteenth meeting of the International Congress of Ophthalmology in Cairo, Dec. 8-14, 1937.)

Further analytic studies of the herpes virus and other viruses must be conducted along biochemical rather than along morphologic lines.

HISTOLOGIC STUDIES OF HERPETIC VACCINATION KERATITIS. DR. K. A. REISER, Bonn.

The neural apparatus of the corneal parenchyma shows no uniform changes in cases of herpetic vaccination keratitis. Changes in the coarse nerve fibers and the cells of Schwann are seen only after keratitis has existed for some time. These changes appear only in single nerve trunks, while others remain unchanged. Sensory changes which occur in association with herpes cannot be explained on the basis of histologic changes in the nerve fibers.

Since a cellular infiltration of herpetic keratitis follows indefinite direction along connective tissue fibers and nerve fibers, the structures immediately in their course are rapidly dissolved by the ingrowing cells before they can cause damages in other structures. The sensory disturbances which are always present with herpes of the cornea must be attributed to these changes.

A PREVIOUSLY UNDESCRIBED DOMINANT HEREDITARY DYSTROPHIA EPITHELIAS CORNEAE. PROF. A. MEESMANN, Kiel.

A new disease complex, dystrophia epithelias corneae occurred in 26 members of 3 families. The disease began during childhood. (The youngest patient was 3 years of age.) At puberty definite attacks of pain and ciliary injection occurred, which were followed by slight changes due to irritation. The changes in the cornea were purely epithelial and were seen with the slit lamp beam as fine, closely packed droplets of varying size and as roughening of the corneal surface. The zone of the limbus was not excluded. The substantia propria and the endothelium were not affected. During childhood, eczematous corneal processes occurred frequently, and at times scars were seen in the deeper corneal layers. Scars in 4 older patients were markedly changed by deposition of a honey yellow substance. In uncomplicated cases visual acuity was moderately reduced to about 5/15. Anatomically, there was found focal dystrophy of the middle epithelial layers, with increasing cellular degeneration at the surface and intracellular vacuole formation. The demarcation of this from other types of corneal degeneration is evident by the limitation of the process to the epithelium and the extension to all of the epithelium—to the rim of the cornea and including the adjacent sclera.

TERMINAL RETICULUM AND GANGLION CELLS IN THE PLEXUS CILIARIS. DR. H. KRÜMMEL, Greifswald.

In human eyes the nerves of the ciliary body form a syncytial network rich in fibers, which penetrate all of the musculature. The terminal structure of this network is incompatible with the teachings of the neuron theory, which states that the individual nerve fibers are processes of individual ganglion cells and have their isolated endings in the cells of the affected organ. This network, however, maintains its syncytial

character, even to its finest ramifications, and forms a flat, fine meshed, terminal reticulum, even at the closest synapse with the plasma of the muscle cells.

The occurrence of ganglion cells in the plexus ciliaris was debated previously, but I definitely found ganglion cells. They lie isolated in the ciliary body and are almost exclusively bipolar and little differentiated.

In this investigation I used the silver method of Bielschowsky and Gros in an eye of a person who was executed and in one eye which was removed because of a sarcoma of the choroid.

DETACHMENT OF THE VITREOUS. DR. H. RIEGER, Vienna, Austria.

Fifteen cases of detachment of the vitreous in children and in young adults were studied. The detachments of the vitreous in the children differed from those in the adults in their precipitating causes. Myopia, which is the main cause of detachment in adults, is not so important in children. It is myopia of high degree associated with developmental anomalies which leads to detachment of the vitreous rather than myopia associated with inflammatory changes of the choroid and of the optic nerve. Thus detachment of the vitreous was observed in children with fully developed nerve fibers and a high degree of myopia at an age at which, in view of past experience, detachment of the vitreous would have seemed most unlikely. Similar conditions obtain in cases of myopia associated with coloboma of the choroid and of the optic nerve. The youngest of my patients was a girl 5 years old who had fully developed nerve fibers and myopia of 13 diopters. Preretinal and vitreous hemorrhages are more significant in the child than in the adult. Particularly remarkable is the fact that tapetoretinal degeneration not infrequently leads to detachment of the vitreous in children. True inflammatory detachment plays a minor role in children. The occurrence of detachment of the vitreous during childhood makes it possible for one to understand retinal detachment at that age. In 6 of my cases spherical formations occurred in the vitreous. Contrary to the previous opinion that these structures are situated within the vitreous, I found by means of the Lindner microscope that they were in the space of the vitreous body, not far from the retina. They cast a shadow on the fundus and because of their peculiar motility gave the picture of solid structures which were adhering to the posterior surface of the detached posterior limiting membrane of the vitreous body. Histologic sections of an eye with detachment of the vitreous associated with uveitis and secondary glaucoma verified the clinical observation. The cases of Aust, Hess and Litinsky in the literature may be interpreted in a similar manner.

Third Scientific Session

Tuesday, July 5, 1938

PROF. ADOLF JESS, LEIPZIG, *Chairman*

PATHOLOGIC CHANGES IN THE "BORDER ZONE" OF THE EYE. DR. WALTHER REICHLING, Berlin.

By the term "border zone" I refer to those areas which surround a basal membrane, or a basal membrane-like skin, and its covering cell

layer. Such border zones include: (1) the internal border zones of vessels, (2) the border zone of the lamina vitrea, (3) the capsular zone of the lens, (4) the border zone of Descemet's membrane and (5) the border zone of Bowman's membrane. Pathologic examination of vessels has demonstrated for some time a newly formed tissue layer between the inner border membrane and the endothelium. This arises from a widening of the basal substance, which, by means of present histologic methods, cannot be analyzed. This widening is effected in the vessels of the eye by histolysis of the subendothelial basal substance and its transformation by organization. I started my investigation with the newly formed vascular layer between the pigment epithelium of the retina and the lamina vitrea, which represents nothing more than the organization and vascularization of a histolysed subpigmented epithelial basal substance (in the border zone of the lamina vitrea). The object of my studies was to find a common pathogenic denominator. A common tendency to these changes could be demonstrated in all border zones.

A similar process could be demonstrated in the changes in the internal elastic membrane of vessels and the lamina vitrea. It consisted of (1) segmental destruction and hyaline degeneration. The changes in the subpigmented epithelial basal substance were more variable and more pronounced (in the border zones of the lamina vitrea) than the changes in the subendothelial basal substance of the vessels. Different types of cysts, already described in the literature, may be explained as peculiar forms of changes of the histolytically changed subpigmented epithelial basal substance. To this group belong the cysts which are found in close proximity to the point of entrance of the optic nerve. Ossification frequently occurs in this subpigmented epithelial basal substance.

This pathogenic explanation is of interest because other changes in other border zones of the eye can be explained on the same basis. In the border zones of Bowman's and Descemet's membranes, tissue substrates can be demonstrated between the limiting membranes and their covering epithelium, which in comparison with the corresponding pictures of the pathologic changes in the border zone of the vessels and the lamina vitrea, lead to one concept; that is, that histolysis of the subepithelial basal substance, with following organization, also occurs in these two border zones of the cornea. All pannus formation is included in this concept. Experimental evidence in the rabbit eye (infra-red radiation of the rabbit eye, Kleiber; inoculation tuberculosis in the rabbit eye, Reichling) supports this concept in regard to the border zone of Descemet's membrane.

ORIGIN OF THE VESSELS IN THE EMBRYONIC VASCULAR LAYER BETWEEN THE PIGMENT EPITHELIUM OF THE RETINA AND THE LAMINA VITREA. DR. F. KLEMENS, Berlin.

Microscopic serial sections and photomicrographs show that the vessels in the layer between the pigment epithelium and the lamina vitrea arise from the vascular system of the choroid and the ciliary body. The vessels originating from these vascular regions perforate the lamina vitrea near the ora serrata at the distance of a few milli-

meters from the pars plana. The penetration of the vessels in the area is frequently associated with penetration of fragments of pigment epithelium. No connection of the retinal vascular bed with the newly formed vascular layer could be determined. This is further indication that the retinal vascular system is an independent one, as was shown by Leber and Donders. Whether these vessels penetrate the lamina vitrea through preformed perforations or by themselves is not as yet established and is still under investigation.

Histologic Changes in the Ora Serrata of the Human Eye in Equatorial Sections. Dr. Hans Weber, Berlin.

Numerous equatorial sections of two eyeballs were studied. It was found that the ora serrata ran temporally as a slightly wavy line, while nasally there were dentated processes. Twenty-two of these dentations were counted; in nine peculiar fragmented structures were found which showed concentric layering, and in some instances these structures were connected to the lamina vitrea by a peduncle. It seemed significant that capillaries were always found between the lamina vitrea and the pigment epithelium at the base of the retinal dentations with fragmented deposits. In several instances these capillaries had penetrated the lamina vitrea from the choroid. These capillaries are connected pathogenically with the granular structures. The latter are products of exudation, and the perforation of the vessels through the lamina vitrea is a pathologic process. The newly formed vessels lie in the space which at onset of the pathologic process is filled by basal substance, which is changed histolytically. The penetration of the vessels is a secondary process and occurs through preformed holes developed in the course of the inflammatory process.

Discussion on Papers by Dr. Reichling, Dr. Klemens and Dr. Weber

Prof. O. Marchesani, Münster: I have seen the connective tissue layer with vessels between the retina and the pigment epithelium in the healthy eye and particularly in the inflamed eye. A connection with the choroid is not always found. The connective tissue and the vessels could develop from the pigment epithelium. This would mean that one is dealing with a mesodermal anlage, comparable to the primitive mesodermal anlage seen during embryonic development. The ability of pigment epithelium to form mesoderm is due to its primitive type of epithelium, which from early embryonic development undergoes no change and remains in the primitive stage of simple, one layer epithelium.

"Peristatic" Conditions Associated with Incomplete Occlusion of the Central Artery. Prof. Werner Kyrieleis, Hamburg.

The term peristatic condition was introduced by Ricker, who applied it to a functional process in the vascular system (dilated peripheral vascular bed proximal to the contracted arterial system). Ricker's theory is borne out by the changes in the fundus of malignant hypertension and albuminuric retinitis. Clinical observations were made on 3 patients with incomplete arterial sclerotic occlusion of the central

artery, in whom, partly because of organic, and partly because of functional, causes, a circumscribed narrowing in the arteriolar flow was produced, so that in the sectors away from the narrowed vascular segment a peristatic condition was present which could be observed with the ophthalmoscope. In the area supplied by the affected artery a circumscribed edematous swelling of the retina was seen in all 3 cases, and in 1 of these hemorrhages developed. I see in these observations proof that peristatic circulatory disturbances actually lead to the extravasation of fluid and cellular blood constituents through the wall of the vessel. This increased permeability of the peripheral vessels is probably caused by impaired nutrition, and therefore I propose the term dyshemic instead of the term ischemic.

HYPERERGIC REACTION IN THE RETINA. DR. REINHARD BRAUN, Rostock.

The concept of allergic and hyperergic reactions of the organism to various infections diseases, such as the streptococcic diseases (scarlet fever, periarteritis nodosa and glomerulonephritis), is important in interpreting disease processes in general medicine. In ophthalmology, keratitis parenchymatosa and sympathetic ophthalmia are conceived to be of an allergic nature. I believe that this point of view is also applicable to iritis. A 23 year old diabetic patient clinically showed the typical retinal changes of white plaques, hemorrhages and normal papillae as well as granulomas, which consisted of young connective tissue cells and some lymphocytes, and hyalinized vessel walls. These granulomas were found in all layers of the retina; the choroid was not involved. Associated with the diabetes, the patient had a slight chronic inflammatory disease of the kidney, with normal blood pressure but some retention of nitrogen. One eye was enucleated because of secondary glaucoma. The general condition was satisfactory three and one-half years later. It was assumed that the diabetes and the renal condition jointly produced the changes in the retina. This type of reaction is unknown in diabetes. It is therefore considered as part of the same process which produces the changes in the kidneys and probably throughout the organism. There is a possible relation of this observation to the findings of Marchesani in cases of periphlebitis retinae.

DISCUSSION ON PAPERS BY PROFESSOR KYRIELEIS AND DR. BRAUN

PROF. R. SCHEERER, Stuttgart: I consider the peristatic hyperemia in cases of occlusion of the retinal artery without arteriosclerosis as more pronounced. While the retinal vessel is occluded, the edema is not present but occurs only after the retinal vessel dilates again. The edema subsequently is absorbed, the absorption beginning when the arteries resume their normal state, and one is able to obtain the arterial pulse by pressure on the eye.

PROF. CARL MYLIUS, Hamburg: I consider peristatic hyperemia as important for the development of some changes in the retina. I observed such changes, namely, peristatic conditions, in my patients with eclampsia, before the onset of retinal changes. In my publication of 1927 I considered peristatic hyperemia as the primary cause of the retinal changes.

PROF. O. MARCHESANI, Münster: In my cases of juvenile retinal disease and of mild diabetes and renal damage I consider the ocular changes as part of the systemic reaction of the mesenchymal weakness.

PROF. A. PILLAT, Graz, Austria: I consider the best illustration of peristatic conditions to be those associated with uncomplicated hypertension of the retinal vessels.

PROF. WERNER KYRIELEIS, Hamburg: The increased permeability of the peripheral vascular bed is produced by the interplay of many factors, but I consider the observable changes in the vascular flow which produce dyshemic disturbance in nutrition as the most important.

DOES THE POSSIBILITY OF TREATING A HEREDITARY DISEASE EXCLUDE IT FROM THE LAW PROVIDING FOR STERILIZATION? PROF. BRUNO FLEISCHER, Erlangen.

The recent laws for sterilization to prevent the hereditary transmission of diseases bring up the question whether congenital cataracts should be included as one of the ocular diseases covered by this law. Statistics of results from operations on hereditary cataracts in my clinic and in other clinics show the frequency of complications (microphthalmos, nystagmus, amblyopia, etc.). The comparatively poor results from the surgical treatment of congenital cataracts lead me to consider it a disease which is not likely to be cured by such measures. I consider congenital cataract as coming within the aforementioned law.

DISCUSSION

PROF. ENGELKING, Heidelberg: I do not agree with Professor Fleischer. I do not consider congenital cataract a cause for sterilization. It is also inconsistent to apply the law to color blindness and microphthalmos. Those persons who are totally color blind but have good visual acuity and those with microphthalmos in whom it cannot be proved as a definite inherited characteristic should be excluded from the sterilization law.

PROF. W. CLAUSEN, Halle: I advocate sterilization for the foregoing conditions because of their frequent association with other congenital anomalies.

PROF. KARL VOM HOFE, Cologne: I advocate better selection of subjects for sterilization. There are doubtlessly some purely hereditary cataracts in which in several generations operation is followed by good to very good visual acuity. If Professor Fleischer advocates sterilization in these cases, he should also advocate a change in the wording of the law, because at present it is difficult to convince a person that he is "blind" if he has good vision after removal of the cataract.

PROF. DR. MAX BÜCKLERS, Tübingen: The law provides sterilization only for complicated cataracts.

PROF. A. MEESMANN, Kiel; DR. F. WECKERT, Goslar; DR. ROLF SCHMIDT, Freiberg, and PROF. A. ELSCHNIG, Marienbad: (On the basis of their experience and social conscience these men discussed the pros and cons of the applicability of this law to congenital cataract. The opinions seem equally divided.—Abstracter.)

THE VALUE OF DETERMINING VISUAL ACUITY FOR EVALUATION OF COMPENSATION. PROF. KARL SCHMIDT, Bonn.

Direct numerical comparison of the visual acuity of persons with myopia and with astigmatism as determined by the Schweiggert and Löhlein test methods produces variable results. More uniform conditions in illumination, testing distance and other factors should be used in testing these persons and in evaluating the results, or at least the conditions under which the examination is done should be accurately reported.

THE PROBLEM OF SIMPLIFYING AND STANDARDIZING THE DETERMINATIONS OF PERFORMANCE OF THE EYE IN PUBLIC SERVICE. DR. KARL VELHAGEN, Halle.

I have undertaken the problems of classifying on a useful basis the determinations of performance of the visual organs as applied in public service. The classification is based on the old army requisites. The grading is done on the basis of four, or quarters of normal visual acuity, so that the visual ability without glasses is rated above a base line and that with glasses is indicated below the line. The two eyes can compensate for each other on this basis, if the required total sum meets the required standard. With this method of grading, the number of groups in the classification can be markedly reduced. This simplification is of definite value to both the state and the individual and is applicable to all types of public service.

DISCUSSION ON PAPERS BY PROFESSOR SCHMIDT AND DR. VELHAGEN

PROF. WALTER LÖHLEIN, Berlin: Serious diseases may be easily overlooked during an ordinary test owing to the mild demands made on the visual ability. In giving a verdict on compensation consideration should be given to whether the visual impairment is a particular handicap in the occupation of the person seeking compensation. Further, it is important to consider the relative loss of visual power, especially in some occupations. To illustrate, a navy officer came to me because of rapid decrease in visual power in the right eye. A test for vision indicated 5/4; in spite of this a marked decrease of visual power was present, owing to a hereditary macular degeneration. This decrease was verified by finding vision of 8/4 in the other eye. In other words, although the diseased eye still had vision with a normal range, it represented a marked relative decrease. This is important in evaluating the compensation.

PROF. H. ERGGELET, Göttingen: In considering the proposed modifications of Dr. Schmidt, I feel that the old method of indicating visual power with such figures as 4/10 or 10/20, etc., is a much more reliable one, for these figures actually express something definite. In giving these figures both for near and for far vision, the type of chart used should be indicated, because it will make it possible to settle some of the contradictory reports obtained for the same patient with different examinations.

DR. HUGO CAANITZ, Kiel: I agree with Professor Schmidt that the results of the tests should be comparable, but I feel that the test distances

should be given. The present systems and classifications are inadequate and lack uniformity. I feel that Dr. Velhagen's suggestions might serve as a basis for developing a uniform system.

PROF. E. ENGELKING, Heidelberg: I question the practical applicability of the principle of summation in evaluating the acuity of the two eyes. At the International Congress of Ophthalmology in 1929 this problem was widely discussed, and the principle of summation was discounted by all the investigators.

PROF. C. H. SATTLER, Königsberg: I agree with Dr. Velhagen that the books stating the requirements in vision in the occupational groups are mostly antiquated and need constant revision. I believe it advantageous to have the numerous smaller industrial concerns fit their requirements to those of larger industrial organizations. This would help to simplify matters greatly.

DR. J. JUNG, Cologne: I feel that the classification as suggested by Dr. Velhagen is inadequate.

CAUSES OF BLINDNESS DURING ANTIQUITY. DR. A. ALBERT M. ESSER, Düsseldorf.

A search of the ancient literature for descriptions of causes of blindness revealed extensive reports in the medical and the general literature which give surprising insight and extensive knowledge of the various etiologic agents of blindness.

I also found clear differentiation between blindness due to unknown causes, such as predisposition and heredity, and blindness the causation of which is plainly understood. In the first group are congenital blindness, with or without obvious congenital anomalies, and blindness developing in later life due to hereditary tendencies in families and in racial groups. The second group consisted of blindness due to poisons, injuries, excessive light and darkness, cold, physical exhaustion and psychic influences.

CAUSATION OF RETROBULBAR NEURITIS. DR. PAUL CIBIS, Heidelberg.

The question of the causation of retrobulbar neuritis in 189 cases at the ophthalmic clinic and in 580 cases of fully developed multiple sclerosis at the neurologic clinic at Heidelberg University has been studied. On the bases of this study the conclusion was reached that multiple sclerosis is probably the basic factor in retrobulbar neuritis.

Further statistical studies of reports in the literature strengthen this assumption. The increased occurrence of retrobulbar neuritis during 1922, 1927, 1928, 1936 and 1937 could be traced to multiple sclerosis in the majority of cases.

DISCUSSION

PROF. WALTER LÖHLEIN, Berlin: I agree that multiple sclerosis is sometimes an etiologic factor in retrobulbar neuritis. However, retrobulbar neuritis does occur in conjunction with tumors in the anterior cranial fossa. This condition should not be confused with multiple sclerosis. Poisoning with tobacco, alcohol and arsenic is a precipitating

factor of retrobulbar neuritis. In a case in which arsenical poisoning was definitely proved as the etiologic agent, the condition improved markedly after elimination of the arsenic.

PROF. E. ENGELKING, Heidelberg: Statistical studies on selected cases over intervals of time present flaws. However, I do feel that there is some definite value in the report of Dr. Cibis.

EFFECT OF INSULIN ON THE EYE OF A NONDIABETIC PERSON. DR. ROLF SCHMIDT, Freiberg.

Six hundred and fifty shock conditions were studied in 88 schizophrenic patients. While no permanent changes could be demonstrated at the end of the course of treatment, in some of the patients loss of tone of the external ocular muscles, which varied in duration, could be seen during shock. Divergence appeared at times in patients with latent strabismus. Occasionally a horizontal nystagmus occurred. In 55 per cent of the patients a positive oculocardiac reflex was obtained.

PREVENTION OF INFECTION OF A WOUND IN THE EYE. DR. HELMUTH DÖHMEN, Frankfort on the Main.

The best antiseptic medication for the eye is an oily solution, for it has an intensive and long-lasting effect. From preliminary experiments it is seen that the pneumococci are effected by a solution of ethylhydrocupreine hydrochloride and the streptococci and staphylococci by an acridine dye derivative (2-ethoxy-6,9-diaminoacridinum hydrochloride; rivanol). For the preoperative treatment of corneal injuries or purulent infections, an oily solution of this acridine dye derivative and ethylhydrocupreine hydrochloride is recommended. Beneficial effects were obtained in many cases with this solution.

By the addition of "psicain-new" (benzoyl-d-ψ-ecgonin-n-propyl-ester hydrochloride) to this antiseptic, an anesthetic effect was obtained, which proved advantageous in the removal of foreign bodies and erosions of cornea.

HYPERTONIA OF RETINAL VESSELS WITH ENDARTERITIS OBLITERANS AFTER INJURY BY ELECTRIC CURRENTS. DR. J. KLAR, Katowice, Poland.

A 27 year old man was hit by a high tension current of 60,000 volts, sustaining a severe injury to the right side of the head and face which extended to the left upper extremity and included the axilla. As a result of this injury, sclerokeratoconjunctivitis, uveitis, optic neuritis, retinal hemorrhage and bilateral cataract could be observed in addition to edema of the lids. There was a high degree of hypertension in the retinal vessels and an obliterating endarteritis in the right retina, with corresponding loss of the lower visual field. The arterial hypertension was considered the result of the direct effect of the electric energy on the vessels, their nerves and the vasomotor center; while in contrast, the hypertension in the veins was thought to be secondary to increased pressure of the intraocular fluid. The pathogenesis of the endarteritis obliterans was undecided. It may have been the result of the heat, or as Jellinek theorizes, the electroenergetic effect.

DISCUSSION

PROF. ADOLF JESS, Leipzig: In 1 case a current of 220 volts produced an embolus of the central artery of one eye. I corresponded with engineer Alvensleben in regard to this case. All accidents due to contact with an electric current during the last thirty years have been reported to him; he stated that he had never seen such an occurrence from an injury of this type. Corresponding experiments on animals have never produced vascular disturbances of the eye.

DR. J. KLAR, Katowice, Poland: No instance of vascular changes after electric trauma are reported in the literature, except during the recent period when Jellinek reported thromboses in the skin, internal organs and brain secondary to electric trauma.

A RARE INJURY TO AN AVIATOR WITH REMOTE EFFECT ON THE EYE. DR. P. STOCKHUSEN, Jena.

Compression of the thorax occurred in a youth of 18 years who fell 10 meters in a glider. The temporary compression of the thorax at the impact produced swelling of the face with occasional petechiae in the face and neck and hemorrhages in the retinas along the veins. Peculiar milky, cloudy, edematous areas could be seen on ophthalmoscopic examination. The papillae showed the beginning of choked disk. Visual acuity was markedly decreased. There was a bilateral central scotoma, with a decrease in vision to 1/50. In the course of a few weeks the hemorrhages were absorbed, but the disks presented a picture of simple atrophy of the optic nerve.

No improvement of vision occurred. The striking ophthalmoscopic findings in the presence of little general changes are explained by the compression of the thorax and venous stasis of the upper portion of the body. The atrophy of the optic nerve was caused by hemorrhages from the central veins and hematomas of the sheaths of the optic nerves.

DISCUSSION

PROF. A. WAGENMANN, Heidelberg: I find this report interesting, because it reminds me of a case in which a man fell with an elevator and presented similar changes about the face and neck and some retinal hemorrhages.

DR. JOSEPH URBANEK, Vienna, Austria: The disease picture presented here coincides with that observed by me, which was due to fat emboli. In an article in the *Archiv für Ophthalmologie* (131: 147, 1933) I described changes in the fundus consisting of fat emboli in the retinal vessels. They accompanied fractures of bone and compression of the thorax and were definitely established on the basis of histologic studies.

CHEMICAL CHANGES IN THE BLOOD OF PATIENTS WITH GLAUCOMA. PROF. HANS SCHMELZER, Erlangen.

Fifty-five persons with primary glaucoma and, for comparison, 45 persons with normal intraocular pressure were subjected to a systematic study of the blood. They were all clinical patients, subject to the same environment and all about the same age. Forty cubic centimeters of blood was removed from each patient every morning during fasting, and

the values for bilirubin, uric acid, blood sugar, cholesterol and indican were determined. Further, a test for xanthoproteins in the serum was made by the method of Becher. The urine was studied for sugar, protein and urobilinogen contents. In the 55 cases of glaucoma the bilirubin content was increased to ten times its normal value, the blood sugar, four times, and the uric acid content to two times. The cholesterol content was markedly increased in 51 of 55 patients with glaucoma, to an average of 281 mg. per hundred cubic centimeters. In comparison, this increase was found in only 15 of the 45 control patients. The indican content of the serum was never increased. The test for xanthoprotein gave normal values in only 7 of 55 patients with glaucoma in contrast to 33 normal values among the 45 controls. I plan to do further studies, particularly on protein metabolism, but I feel justified in assuming that there was impairment of the hepatic and renal function in the patients with glaucoma. However, I cannot conclude how much of a part this impairment plays in the production of the glaucoma. I suggest the addition to the local treatment of glaucoma of such general measures as the ingestion of a liver-protecting diet (poor in proteins and fat), the discontinuance of the ingestion of poisons usually eliminated by the liver, and in some cases the administration of small doses of insulin (5 to 10 units a day). I shall report my experiences with such general measures at a later date.

PROFESSOR KRUSIUS, Helsingfors, Finland: I welcome these studies, for I have felt that such general measures were of benefit to the patient. I am glad to see some concise clinical data encouraging the use of these procedures.

THE POSSIBILITIES OF SHORT WAVE IRRADIATION IN OPHTHALMOLOGY. DR. HANS SCHEYHING, Munich.

The results of irradiation in 75 patients with ocular conditions stimulated experimental studies on the effect of irradiation on infections artificially induced with Staphylococcus albus in the eyes of rabbits. Further, normal rabbit eyes were subjected to similar irradiation and studied for detrimental effects. The apparatus used was the ultratherm, which has a constant wavelength of 6 meters. The number of irradiations varied from five to twenty, with daily doses of ten to fifteen minutes. The Schliephake glass electrodes were used. Heat tension varied between 17½ and 18. Long periods of irradiation with a tension of 17½ produced no visible changes in the normal rabbit eye. Tension of 18 led to transient clouding of the corneal surface and more severe permanent damage to the lids. After studying the normal eye, the effect of short wave irradiation was studied (1) on fresh corneal infection, (2) on staphylococcic infection produced in the anterior chamber and (3) on staphylococcic infection in the vitreous. For each experiment 2 animals were used, only 1 being subjected to irradiation. Irradiation favorably affected the corneal ulcerations; the lesions in the untreated eyes healed more slowly. The scars in the irradiated eyes were smaller and more delicate than those in the control eyes. Irradiation of staphylococcic infection of the anterior chamber produced resorption and healing, with remaining delicate deposits on the iris and about the pupillary border. Healing of the lesion in the control animal produced a thick scar in the pupil, and the purulent process affected the cornea and led to purulent

necrosis. About fifty organisms were injected into the vitreous of the rabbits used for the third experiment. Irradiation had no effect, and panophthalmia developed in both animals.

The experimental results of irradiation of the infected cornea and the anterior chamber in the eye of the rabbit are in agreement with my clinical experiences, which indicated that the more superficial acute infections of the eye are favorably affected by short wave irradiation. Also, the deeper lying infections fail to respond clinically to treatment with shore wave irradiation.

DISCUSSION

PROF. KARL VOM HOFE, Cologne: Observation of 200 patients treated with short wave irradiation showed that purulent infection of the lids and the lacrimal sac responds favorably. That superficial keratitis and acute iritis heal after short wave irradiation is not unusual, for they heal as well without irradiation.

DR. SCHMIDT: I have used short wave irradiation in several hundred cases and have obtained no conclusive results in cases of severe herpetic keratitis. I question the parallel of the experimental works to clinical situations, because the irradiated rabbit eyes were treated immediately after artificial infection, before clinical manifestations occurred.

DR. FISCHER: I found no conclusive results with the use of short wave therapy in cases of infection of the cornea or the bulb.

DR. HANS SCHEYHING, Würzenberg: In answer to the objections of Dr. Schmidt, in further experiments similar beneficial results were obtained from short wave irradiation when the treatment was started two days after the initial infection in the rabbit eye.

STUDIES ON THE PERMEABILITY OF HUMAN AND ANIMAL CORNEA TO SOLUTIONS OF SODIUM FLUORESCEIN. DR. RUDOLF KLAR, Bonn.

The 0.4 per cent solution of sodium fluorescein used in the ophthalmic clinic at Bonn was found to diffuse into the anterior chamber in a number of patients with infectious and traumatic injuries to the cornea. This same solution was found to diffuse through the cornea of rabbits, dogs and monkeys, while the normal human cornea was not found permeable to this substance in this concentration. Further experimental work on the normal healthy human corneas with 0.5, 1, 2, 3, 4, 5 and 10 per cent aqueous solutions showed that only the 10 per cent solution permeated into the anterior chamber after repeated instillation in the conjunctival sac. These instillations produced no inflammatory reaction. The simultaneous administration of mydriatic, miotics, astringents and surface anesthetics had no effect on the diffusion of the fluorescein. On the basis of this work, I consider that the 4 per cent solution is adequate for all clinical purposes. One should beware of making conclusions concerning diffusion in the human eye on the basis of experimental work on animals.

DISCUSSION

PROF. KARL VOM HOFE, Cologne: I found fluorescein in the anterior chamber of persons with damage to the corneal surface. It disappears slowly from the anterior chamber, being demonstrable by slit lamp examination two days later. In experimental work on the rabbit, instil-

lation of fluorescein in the two eyes and of physostigmine salicylate in one eye for two or three days showed that the fluorescein disappeared much more rapidly from the anterior chamber of the eye treated with physostigmine salicylate.

THE DIAGNOSIS OF PARALYSIS OF THE OCULAR MUSCLES. DR. H. HARMS, Berlin.

A new instrument has been devised for the quantitative measurement of paralyses of individual ocular muscles. This method is a modification of that originated by Hofmann and Bielschowsky.

DISTURBANCES IN COLOR SENSATION ASSOCIATED WITH OPERATIONS ON THE RETINA. PROF. E. ENGELKING and DR. E. SCHRECK, Heidelberg.

Careful studies over periods of many years of the visual fields of patients who were successfully operated on for detachment of the retina according to the method of Weve gave different typical disturbances in the color sense. The following conclusions were made: An increase of all color thresholds occurs in the area of the margin of the scar. Perimetric tests show that the usual sense of blue-yellow, but not the sense of white, is lost in the scarred area.

The visual field of persons subjected to retinal operations may change considerably even after months and years.

Visual fields which immediately after healing seem considerably reestablished may some time later show regional or concentric narrowing for all qualities, although the retina is completely attached. These disturbances must be considered as progressive concomitant disturbances in the color sense which express changes in the retina due to the detachment and which occur irrespective of the operative procedure.

Finally, some patients, even many years after a successful operation may show without a recurrent detachment a so-called blue blindness, which is mostly regional and limited to the vicinity of the operative scar. This disturbance in blue sense does not necessarily accompany the typical decrease of dark adaptation. Most eyes which have healed after an operation on the retina show some increased threshold in comparison with the healthy eye. In patients with a secondary disturbance in the blue field, the dark adaptation is by no means worse; also, chromatopsia is not found in association with secondary disturbances in the blue field, which is in contrast to the primary disturbances. The fundus shows either no change or only slight clouding of the tissue in this area. Perhaps a slight increase in the intraretinal fluid content plays a role in the occurrence of this secondary disturbance in the blue field. Such a disturbance is reversible in many cases.

Careful studies of the visual fields, with particular study of the blue and yellow fields, proves to be a method which enables one to demonstrate fine pathologic processes in the retina of patients operated on for amotio retinae. These changes are not demonstrable on examination with the ophthalmoscope and the customary tests for function.

The appearance of a secondary disturbance in the blue field does not mean a new detachment but naturally affords another accurate observation of the affected retina.

Fourth Scientific Session

Wednesday, July 6, 1938

PROF. SEEFELDER, INNSBRUCK, AUSTRIA, *Chairman*

THE PROTEINS OF THE LENS. PROF. ADOLF JESS, Leipzig.

The investigations regarding the protein of the lens which have been made in the course of the last decade, after interest was aroused by Uhlenhuth's discovery of organic specificity and the absence of type specificity, have been chronologically reviewed. All articles go back to the chemical studies of the protein of the lens by the Swedish physiologist Mörner, who determined that besides the insoluble protein, albumoid, three soluble proteins are present, which he called alpha crystalline, beta crystalline and albumin. My work has been stimulated by the report of Reiss of the absence of the cysteine reaction in the normal and the cataractous lens. I determined that this reaction, which was based on the amino-acid cysteine in the protein, was completely negative with albumoid, weak with alpha crystalline and very strong with beta crystalline. From this I concluded that the essential substance, cysteine, was mainly attached to beta crystalline. Splitting of the protein of the lens into individual constituents by the method of Emil Fischer and of Kossel and Kutscher showed that certain differences were present, particularly in regard to the low content of alanine and valine in the albumoid and the small quantity of leucine with comparative large amounts of valine in beta crystalline. On the basis of the results of studying the products of decomposition of protein, I group the crystalline products among the albumins and no longer with the globulins, since they contain about 15 per cent arginine, lysin and histidine and therefore must be considered 85 per cent monoamino acids. The albumoid apparently represents a transition to the globulins and seemingly has nothing in common with the structural albumin, which according to Abderhalden is almost completely composed of monoamino acids. It is noteworthy that glycocoll is completely absent in all lens proteins, as found by Abderhalden and Weil in the proteins of the central nervous system. Rechecking of the findings of Mörner and Jess by various authors has always given the same results. Glutathione, which was first found by Hopkins to be a reduction-oxidation factor and which is the dipeptide of glutathionic acid and cysteine, which is of prime significance in internal respiration, was also demonstrated in the lens by Goldschmidt. The report that ultraviolet rays can destroy the cysteine reaction of the lens has not been verified, nor can this effect be obtained by infra-red rays. During the last decade it has been primarily the Japanese and Americans who have studied the lens proteins, and their results have been contradictory. The same is true of the biologic behavior of the individual types of lens protein. Great difficulties confront the clinician who attempts research in this field. It is hoped that the younger research workers in different fields will combine and cooperate in attacking these difficult problems of the chemistry of the protein in the lens, as it is done in the other countries.

THE GENESIS OF SENILE CATARACT. DR. H. C. MÜLLER, Berlin.

The cell dies because it is included in the workings of the organism. The changing relations of the cells, produced by the demands of the organism as a whole, form the basis of senile death of the cell. The lens fibers die of old age not because they have a limited span of life but because the lens fibers as a part of the body are under the influence of systemic activities and are unable, owing to inherited characteristics, to withstand the constant influence of noxious agents.

Considering the many sides of the changing relation in the course of the organism as a whole, which in the last analysis leads to senile cataract, it can be recognized that in the case of senile cataract the hereditary course is expressed in a different manner. In 1 case the congenital cataract appears as a dominant hereditary factor, while in other cases no hereditary factor can be demonstrated; also the different types of senile cataract indicate a variable behavior of the hereditary factor. The appearance of senile cataract may be influenced by a number of changes in the vicinity of the lens. Volkner showed in his cataract material in Berlin that diabetes mellitus favors the appearance of senile cataract. Further, Seefried demonstrated that in numerous senile cataracts a disturbance in vitamin C metabolism was present. The variability of the clinical picture gives indication for the many sidedness of the factors which lead to senile cataract. Studies on the metabolism of the lens in the process of aging have clarified the many changes which are interdependent.

Vogt considers the medicinal therapy for senile cataract as a Utopia, since senile cataract is a sign of old age predisposed by heredity. I cannot agree with this negative point of view, and I believe that the future will bring a symptomatic therapy which will affect the course of the senile cataract and delay it, although its development will never be completely prevented.

The problem of senile cataract is not a specific problem involving the lens but is a part of the problem involving the retrogressive changes of the whole organism.

DETACHMENT OF THE VITREOUS AFTER INTRACAPSULAR OPERATION. PROF. A. PILLAT, Graz, Austria.

In cases in which the lens was removed within the capsule, slit lamp examination revealed detachment of the vitreous. This raises the question whether the operative procedure was the cause. In 6 of 12 cases the detachment was in the upper part of the vitreous; in the 6 other cases the detachments consisted of 1 bilateral posterior detachment, 1 tentlike detachment, 2 total detachments and 2 lateral detachments. Except for 1 patient, aged 48, the patients ranged in age from 66 to 80. Neither the type of cataract nor the refraction of the eyes seemed of significance in producing detachment of the vitreous. In 9 of 12 cases the lens was removed within the intact capsule, and in 3 the capsule ruptured before delivery of the lens but was extracted with a forceps. Postoperative detachment of the choroid occurred in 1 case. It is undecided whether the individual acts of the intracapsular operation can produce a loosening of the vitreous body. More important for the production of this condition seems to be the fact that the vitreous under-

goes considerable centrifugal movement after complete removal of the lens; it takes over the space of the removed lens and extends forward. Further, the senile changes in the vitreous, such as shrinkage, loss of water and loosening of the connections between the retina and the vitreous, play some role. Even if the detachment of the vitreous occurs more frequently after the intracapsular operation, this is no contraindication to this excellent procedure, because upper and total detachments of the vitreous are not dangerous on the basis of my experiences. In the 12 cases in which detachment of the vitreous occurred, observation over two years showed no evidence of any change or of retinal detachment.

LENS AND HORMONES. PROF. DR. WALTER RAUH, Leipzig.

After a brief discussion of the concept of hormones and after the ocular aspect of disturbances of the hormonal harmony was pointed out, the author discussed the general metabolic changes produced by overfunctioning or underfunctioning of a gland. He pointed out the disturbances in carbohydrate metabolism, protein utilization, lipoid metabolism, calcium content in the blood and metabolism of vitamin B_2 and C, which influences the permeability of the lens. On the basis of such changes in the total cellular metabolism, a change in the composition of the fluids in the chambers of the eye must be expected, and in this way an influence on the lens is possible. Animal experiments have produced classic proof of a disturbance in internal secretion due to loss of the parathyroids. In these experiments it was possible to trace a specific type of cataract through its complete development. Rauh pointed out evidence in the blood of the disturbances of metabolism of the organism and stressed the lowering of the calcium content in the serum, associated with a rise of the phosphorus content. Lo Cascio demonstrated an increase in the p_H with a decrease of ascorbic acid in the fluid of the chamber accompanied by a decrease in the glycolysis of the lens and an increase in the calcium content. Meesmann has added considerably to the reports of tetany cataract in human beings, descriptions of the cataract having been made by Vogt, Knuesel and others. The earliest clouding, before visual disturbances are present, can be determined by the slit lamp. The importance of early recognition of clouding is proved by the results of early treatment. The original results obtained by the injection of parathyroid extract and the administration of large doses of calcium for the purpose of increasing the calcium content have been exceeded by the use of partial products of ergosterol. Since Holz introduced "A. T. 10," a 0.5 per cent solution of dihydrotachysterol in oil, which proved to be most effective for the treatment of patients over a long period of time, and Rauh showed in animal experiments that with early administration of dihydrotachysterol and suppression of tetany the lens remained clear, it can be said that the clouding can be influenced in the beginning stages and will regress markedly but that the advanced forms cannot be influenced. The extensive observations on man by Meesmann gave the same results. Unsolved questions arise in evaluating lamellar cataracts, latent tetany and spasmophilia; the last condition is not affected by dihydrotachysterol.

The types of cataract associated with myotonia and the different dermatoses are probably produced on a hormonal basis, but the offending hormone has not been identified.

Similarly, tetany diabetes has been proved experimentally to form cataracts. Difficulties of recognition of the diabetic cataract arise only in advanced age. The exact mechanism for the development of this type of cataract is not known. The influence on the lens of insulin was reported by Braun, who observed the disappearance of considerable clouding of the posterior surface.

The relation of senile cataract to the endocrine glands, as given by Siegrist, was presented and discussed, with emphases on senile changes of the glands. According to Romeis, the germinal gland holds no primary position in aging and produces only limited hormonal influence. The two definite relations between respiration of the lens and vitamins and the effects of the treatment of tetany with vitamin-like substances suggest further studies of the relation between the lens and vitamins and hormones.

VITAMIN METABOLISM IN CATARACTS. DR. JOSEPH URBANEK, Vienna, Austria.

Attempts to treat and prevent hemorrhages in the anterior chamber of patients operated on for cataract by the ingestion of pure ascorbic acid in the form of tablets or by intramuscular injections were successful. In the course of these studies I determined the balance in vitamin C metabolism, similar to the experiments of Stepp, Schröder, Johnson and Zilva, Harris and Ray, Jezler and Kapp.

The daily excretion of vitamin in the urine after constant administration of ascorbic acid for several days was studied. Many patients affected with cataract showed a delayed excretion, while others gave normal values. At the time of operation samples of the fluid of the anterior chamber were obtained, and this was tested for vitamin C content.

On the basis of 85 patients with cataracts and 70 patients with other ocular diseases, the following summary is presented: 1. The young organism is better equipped with vitamin C than the senile organism. 2. Cataract formation in elderly persons does not parallel a vitamin C deficiency. 3. Although the senile organism contains less vitamin C, one cannot conclude that the developing cataract is due to a vitamin C deficiency. 4. The constant content of vitamin C in the fluid of the anterior chamber is independent of the saturation and indicates that the depletion of vitamin C in this fluid proceeds slower than in the blood serum, and reversely that the enrichment of the fluid proceeds slower than that of the blood serum. 5. There is no correlation between the lens and the vitamin C content in the fluid of the anterior chamber.

DISCUSSION ON PAPERS BY PROFESSOR JESS, DR. MÜLLER, PROF. DR. RAUH AND DR. URBANEK

PROF. W. KRAUSS, Düsseldorf; PROF. KARL LINDNER, Vienna, Austria; PROF. DR. MAX BÜCKLERS, Tübingen, and DR. FISCHER: The following points were brought out by these men: Retinal detachments may heal spontaneously; cataracts may remain stationary for many years

or even permanently, and sometimes cataracts never progress, all of which must be considered in evaluating any therapeutic measures—Abstracter.

One other important possible cause for detachment of the vitreous is suggested as secondary to fistula formation.

THE GENESIS OF CATARACT IN THE LIGHT OF STUDIES IN HEREDITY. PROF. DR. MAX BÜCKLERS, Tübingen.

The contents of this article are discussed in detail in A. Gütt's Handbuch der Erbkrankheiten (Leipzig, Georg Thieme, 1938, vol. 5).

THE DIFFERENTIAL DIAGNOSTIC SIGNIFICANCE OF THE SLIT LAMP PICTURE OF THE LENS. PROF. A. MEESMANN, Kiel.

The evaluation of the changes in the lens as seen by means of the Gullstrand slit lamp is of great importance to the practicing ophthalmologist. Investigators in the last twenty-five years have placed the diseases of the lens on the new basis of diagnostic evaluation in relation to the general disease processes. Questions concerning therapy arise which are of greatest significance, but questions concerning eugenics can be answered only after slit lamp investigation. I wish to stress the needs of the practical ophthalmologist and to consider especially these questions: Which types of cataracts, according to the slit lamp picture, are definitely exogenous? How closely can cataract be allied to the general systemic disease, and from this point of view what therapy can be started? The question of therapy is of particular significance in the diabetic cataract of young persons and the tetany cataract, which can be effectively treated with insulin and a 0.5 per cent solution of dihydrotachysterol, respectively. For the consideration of eugenic questions, it is important to separate the idiotypical and the paratypical congenital cataracts. Also, the exogenous development as a possibility with congenital cataracts is important (uncomplicated lamellar cataracts). The total field of cataracts is arranged in the following manner: (1) congenital cataracts; (2) contusion cataracts; (3) complicated cataracts, and (4) exogenous types of cataracts, namely, the diabetic cataract, the tetanic cataract, the myotonic cataract (occurring with myotonic dystrophy), the syndermatotic cataract (occurring with dermatologic disorders) and other endocrine types of cataract and finally the radiation cataract.

Fifth Scientific Session

Wednesday, July 6, 1938

DR. WIEDERSHEIM, SAARBRÜCKEN, *Chairman*

TOPOGRAPHY OF THE EMBRYONIC LENS. DR. FRANZ FISCHER, Vienna, Austria.

Diapositives were studied to gain a picture of the positional relation of the lens to the eyecup, the pupil and the corneal substructure in the course of its development. In the embryos of 6 to 8 mm. the lens anlage takes in all of the primitive vitreous space. After detachment from

the surface ectoderm (9 to 10 mm.), the hollow lens bubble appears as a triangular structure on sagittal section; the tip overreaches the pupil and lies close to the surface ectoderm. A free vitreous space appears. In embryos of 11 to 12 mm. the lens bubble becomes rounded, the formation of lens fibers from the posterior lens wall has begun and a circumlenticular space is visible. Between the surface ectoderm, which is slightly indented, and the lens, a penetrating layer of mesoderm is found. In embryos of 13 to 15 mm. the lens, the cavity of which is decreased by the forward growth of lens fibers, appears oval. Because of the changed form, greater portions of the anterior lens wall appear in the pupil, without, however, overreaching it. Soon afterward (16 mm. embryo), the lens becomes solid and curves forward over the pupil. The number of mesodermal cells has increased in the space between the ectoderm and the lens. The indentation of the surface ectoderm has disappeared. In the course of further development, the lens comes to lie more and more on the plane of the pupil. At the same time, the circumlental space is narrowed. The vitreous space enlarges. In the embryo of 17 or 18 mm. the lens lies close to the surface ectoderm. In embryos of 19 to 21 mm. it lies so close to the pupil that the equatorial plane coincides with the plane of the pupil. This condition is best designated as physiologic lens fixation. The mesodermal cells lying between the surface ectoderm and the lens form the corneal endothelium.

In embryos of 21 to 25 mm., in which a corneal stroma has already developed, the lens assumes the same position, but a narrow space exists between it and the cornea; this is the anterior chamber. The cornea assumes a curvature which is independent of the lens.

In embryos of 30 to 40 mm. the pupil is still filled by the lens, which transitionally assumes a more spherical form; but with the development of the anlage of the ciliary body the equatorial plane becomes situated again posterior to the plane of the pupil. The distance between the equatorial plane and the plane of the pupil enlarges in the older embryos with the development of the ciliary body and the iris (embryos of 55 and 90 mm.). With the growth of the ciliary body, the anterior chamber becomes deeper, and finally the whole iris, lens and diaphragm move posteriorly. The evaluation of the topography of the lens in the final stages of development becomes difficult because of artificial changes in the preparation. These observations indicate that the formation of the cornea is influenced by the lens. The proximity of the lens to the corneal anlage might be significant for the closure of the mesodermal cells and the arrangement as endothelial cell position. One cannot evaluate to what extent the topography of the lens affects the development of other portions of the body. The stage of "physiologic lens fixation" is the point of origin of different malformations in the area of the anterior segment of the eye. The investigations were made on materials available from 150 human embryos from the collection of the histologic and embryologic institute of the University of Vienna (Prof. V. Patzelt).

DISCUSSION

DR. FRANZ FISCHER, Vienna, Austria: In answer to the question of Professor Scheerer, the designation of the anterior opening of the eyecup as "pupil" is justified. Naturally it is not the same pupil seen in the

adult. The demonstration of the effect of the lens on the development of the corneal epithelium is new.

PATHOLOGIC CHANGES IN THE ANTERIOR SUBCAPSULAR "BORDER ZONE" OF THE LENS. DR. WALTHER REICHLING, Berlin.

I previously reported the histologic changes observed in the basal substances of the internal border zones of the vessels and of the border zone of the lamina vitrea. In the border zone of the lamina vitrea were processes of organization and vascularization which followed histolysis of the subpigmented epithelial basal substance and led to the development of a new vascular layer between the pigment epithelium of the retina and the lamina vitrea. Study of a third border zone of the eye (the capsular zone of the lens) brings forth the question of whether there might not be a basal substance between the capsule and the capsular epithelium which is similar to that in the previously mentioned border zone. Under normal conditions such a layer is invisible, but in the presence of a pathologic condition it might be disorganized, broadened and therefore visible, owing to histolysis. On the basis of the following findings, the presence of such a histolytically changed basal substance could be probable: 1. In eyes with senile cataract a fine granular and fibrillar substrate was found directly under the capsule of the lens. This was definitely differentiated structurally and by staining properties from the lens fibers that were changed by the cataract. 2. In eyes with fibrous subcapsular cataract which developed in the course of chronic iridocyclitis, a fluid substrate was demonstrated between the fibrillar zone and the true lens capsule. Capsular epithelium was either destroyed or displaced centrally by these changes. 3. In experimental rabbits definite detachment of the capsular epithelium from the lens of the capsule was determined. The space between the detached capsular epithelium and the capsule was filled either with an exudate or with a granular coagulated fluid. The composite changes, illustrated by colored diapositives, consisted of a histolytic dissolution and broadening of the basal substance lying between the capsule and the capsular epithelium, followed by organization and the formation of those fibrous types of cataracts designated as anterior capsular cataracts, anterior polar cataracts and pyramidal cataracts. These developments correspond well with pathologic changes consistently found in general pathologic processes in the basal substance of other border zones, especially the border zones of the vessels.

CHANGES IN THE TECHNIC OF THE INTRACAPSULAR OPERATION FOR CATARACT. PROF. KARL LINDNER, Vienna, Austria.

For intracapsular extraction of cataract, I advocate the use of a stronger ligature in the cornea than is used by Verhoeff, of Boston. Because of an increased incidence of infection, I further modified this procedure by placing the suture in the sclera above the limbus. The incision is made more difficult by this previously placed suture. After the incision is made, a peripheral iridectomy is carried out. The lens is then grasped under direct vision with the Verhoeff forceps. The extraction of the lens and the tightening of the ligature follow: if the capsule

tears, one can grasp the lens again by the method of Verhoeff and still remove the lens completely with the capsule. If perforation occurs in the preliminary incision, I recommend that the incision be completed from the exterior. The ligature holds tight; expulsive hemorrhages may start, but they cannot develop further. Since the advent of this type of operation, extracapsular extraction has become the exception.

PROF. DR. MAX BÜCKLERS, Tübingen: I believe that it is best to adhere to the fundamental principles of keeping an operative procedure as simple as possible, so that the average practicing ophthalmologist may perform it without complicated apparatus and even without an assistant.

PROF. KARL LINDNER, Vienna, Austria: This suggested type of operation is of value only to the man with considerable operative practice and facilities, but I believe it of value in increasing the percentage of successful operations even by a small fraction.

THE OPTICAL CORRECTION OF THE APHAKIC EYE. PROF. H. ERGGELET, Göttingen.

In a consideration of the optical consequences of absence of the lens, the following state is presupposed: a round pupil and an unchanged optical zone of the cornea. Difficulties are encountered in evaluating the factors affecting the focus of any given eye after removal of the lens, for the varying optical factors are usually unknown and immeasurable, except for those in the cornea. Calculations which are based on the findings and the presence of a clear lens are unreliable when applied to probable adjustment of the eye after operation. L. Paul considered this uncertainty as minimal. He reported a simple procedure of determining the expectant adjustment from composite pictures. The most frequent necessary correction is from 11 to 12 diopters. With cataract glasses, the retinal image usually is larger than in the normal eye, and an increase of visual acuity above that of the normal eye is made possible. During operation, changes usually occur in the contour of the cornea (not frequently irregular astigmatism) and in the shape and position of the pupil. Therefore, the expected visual acuity frequently is not attained. One cannot assume that accommodation occurs for near vision in the aphakic eye with corrective lenses for distant vision, as is reported frequently. Some peculiarities in the structure of the nerve bundle must be made responsible for this accomplishment. The unintended side effects which result and are unavoidable in a singe lens system, and which arise mainly from the deviation of the major rays, are the source of the difficulties to which the wearer of customary cataract glasses is subjected: They destroy in those with one good eye and one eye without the lens the possibility of binocular vision and utilization of the potential good visual acuity which is present. The use of contact lenses is advised to overcome these and other difficulties. But in employing this excellent aid, one is confronted with the difficulty encountered when using anisometropic glasses, namely, the rapid development of squint in the lensless eye, which sometimes, in spite of complete ability of the patient to fuse, cannot be overcome. Therefore, I advise the early use of contact lenses in aphakic eyes.

Book Reviews

Twenty-Fifth Annual Report of the Ophthalmic Hospital Section for 1937. Ministry of Public Health, Egypt. Price, 10 piasters (about 80 cents). Pp. 47. Cairo: Al-Ettemad Press, 1939.

In 1937 four additional ophthalmic branches were opened, so that the total number of ophthalmic units is now 78. During the past year there were 1,213,781 new patients, and 351,136 operations were performed.

The percentage of patients who were found blind was 5.8 per cent. The cause of blindness in 80 per cent of cases was acute ophthalmia, the gonococcus being the predominating factor in 40 per cent. The number of school pupils examined totaled 12,075, and 99 per cent were found to be suffering from trachoma; the trachoma of 41 per cent was in the serious stage.

Postgraduate teaching was given to 39 students during the year.

Among the operations, 2,227 were for cataract and 112,000 for trichiasis and entropion. Trephining was done in 1,231 cases of glaucoma and iridectomy in 1,473 cases. Of the 68,000 cases of blindness, glaucoma was responsible for 11,000.

The report presents a number of statistical tables.

ARNOLD KNAPP.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6°, France.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the Secretariat, 66 Boulevard Saint-Michel, Paris, 6°, France.

International Ophthalmologic Congress

President: Prof. Nordenson, Serafimerlasarettet, Stockholm, Sweden.
Secretary: Dr. Ehlers, Jerbanenegade 41, Copenhagen, Denmark.

International Organization Against Trachoma

President: Dr. A. F. MacCallan, 33 Welbeck St., London, W., England.

FOREIGN

All-India Ophthalmological Society

President: Dr. B. K. Narayan Rao, Minto Ophthalmic Hospital, Bangalore.
Secretary: Dr. G. Zachariah, Flitcham, Marshall's Rd., Madras.

British Medical Association, Section on Ophthalmology

President: Dr. W. Clark Souter, 9 Albyn Pl., Aberdeen, Scotland.
Secretary: Dr. Frederick Ridley, 12 Wimpole St., London, W. 1.

Chinese Ophthalmology Society

President: Dr. C. H. Chou, 363 Avenue Haig, Shanghai.
Secretary: Dr. F. S. Tsang, 221 Foochow Rd., Shanghai.

Chinese Ophthalmological Society of Peiping

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

German Ophthalmological Society

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.

Hungarian Ophthalmological Society

President: Prof. H. G. Ditroi, Szeged.
Assistant Secretary: Dr. Stephen de Grosz, University Eye Hospital, Maria ucca 39, Budapest.
All correspondence should be addressed to the Assistant Secretary.

Midland Ophthalmological Society

President: Dr. W. Niccol, 4 College Green, Gloucester, England.
Secretary: Mr. T. Harrison Butler, 61 Newhall St., Birmingham 3, England.
Place: Birmingham and Midland Eye Hospital.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and keep it up to date.

NORTH OF ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. A. MacRae, 6 Jesmond Rd., Newcastle-upon-Tyne, England.
Secretary: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield 10, England.
Place: Manchester, Bradford, Leeds, Newcastle-upon-Tyne, Liverpool and Sheffield, in rotation. Time: October to April.

OPHTHALMOLOGICAL SOCIETY OF AUSTRALIA

President: Dr. A. James Flynn, 135 Macquarie St., Sydney.
Secretary: Dr. D. Williams, 193 Macquarie St., Sydney.
Place: Perth, Western Australia. Time: Sept. 2 and 7, 1940.

OPHTHALMOLOGICAL SOCIETY OF EGYPT

President: Prof. Dr. Mohammed Mahfouz Bey, Government Hospital, Alexandria.
Secretary: Dr. Mohammed Khalil, 4 Baehler St., Cairo.
All correspondence should be addressed to the Secretary, Dr. Mohammed Khalil.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

President: Mr. T. Harrison Butler, 61 Newhall St., Birmingham 3, England.
Secretary: Mr. L. H. Savin, 7 Queen St., London, W. 1, England.

OPHTHALMOLOGY SOCIETY OF BOMBAY

President: Dr. D. D. Sathaye, 127 Girgaum Rd., Bombay 4, India.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14, India.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield 10, England.
Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.
Time: July 4-6, 1940.

PALESTINE OPHTHALMOLOGICAL SOCIETY

President: Dr. Arieh Feigenbaum, Abyssinian St. 15, Jerusalem.
Secretary: Dr. E. Sinai, Tel Aviv.

POLISH OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.
Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.
Place: Lindley'a 4, Warsaw.

ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

President: Dr. Malcolm Hepburn, 111 Harley St., London, W. 1, England.
Secretary: Dr. C. Dee Shapland, 15 Devonshire Pl., London, W. 1, England.

SOCIEDADE DE OPHTALMOLOGIA E OTO-RHINO-LARYNGOLOGIA DA BAHIA

President: Dr. Francisco Ferreira, Pitangueiras 15, Brotas, S. Salvador, Brazil.
Secretary: Dr. Adroaldo de Alencar, Brazil.
All correspondence should be addressed to the President.

SOCIETÀ OFTALMOLOGICA ITALIANA

President: Prof. Dott. Giuseppe Ovio, Ophthalmological Clinic, University of Rome, Rome.
Secretary: Prof. Dott. Epimaco Leonardi, Via del Gianicolo, 1, Rome.

SOCIÉTÉ FRANÇAISE D'OPHTALMOLOGIE

Secretary: Dr. René Onfray, 6 Avenue de la Motte Picquet, Paris, 7°.

SOCIETY OF SWEDISH OPHTHALMOLOGISTS

President: Prof. K. G. Ploman, Stockholm.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö.

Tel Aviv Ophthalmological Society

President: Dr. D. Arieh-Friedman, 96 Allenby St., Tel Aviv, Palestine.
Secretary: Dr. Sadger Max, 9 Bialik St., Tel Aviv, Palestine.

NATIONAL

American Medical Association, Scientific Assembly, Section on Ophthalmology

Chairman: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.
Place: New York. Time: June 10-14, 1940.

American Academy of Ophthalmology and Otolaryngology, Section on Ophthalmology

President: Dr. Frank E. Brawley, 30 N. Michigan Ave., Chicago.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: Cleveland. Time: Oct. 6-11, 1940.

American Ophthalmological Society

President: Dr. Frederick Tooke, 1482 Mountain St., Montreal, Canada.
Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.
Place: Hot Springs, Va.

Association for Research in Ophthalmology, Inc.

Chairman: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Secretary-Treasurer: Dr. C. S. O'Brien, University Hospital, Iowa City.

Canadian Medical Association, Section on Ophthalmology

President: Dr. Alexander E. MacDonald, 170 St. George St., Toronto.
Secretary-Treasurer: Dr. L. J. Sebert, 170 St. George St., Toronto.
Place: Royal York Hotel, Toronto. Time: June 19-21, 1940.

National Society for the Prevention of Blindness

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.
Executive Director: Mrs. Eleanor Brown Merrill, 50 W. 50th St., New York.

SECTIONAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

President: Dr. Andrew Rados, 31 Lincoln Park, Newark.
Secretary: Dr. William F. McKim, 317 Roseville Ave., Newark.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

Central Wisconsin Society of Ophthalmology and Otolaryngology

President: Dr. E. G. Nadeau, 122 E. Walnut St., Green Bay.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.
Place: The Gateway Inn, Land O'Lakes. Time: June 1940.

New England Ophthalmological Society

President: Dr. Edwin B. Goodall, 101 Bay State Rd., Boston.
Secretary-Treasurer: Dr. Trygve Gundersen, 243 Charles St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. Frederick G. Sprowl, 421 Riverside Ave., Spokane, Wash.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.
Place: Spokane, Wash. Time: June 24-27, 1940.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. J. Edward Clark, 1305–14th Ave., Seattle.
Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. L. A. Shultz, 303 N. Main St., Rockford, Ill.
Secretary-Treasurer: Dr. J. J. Potter, 303 N. Main St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month from October to April, inclusive.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Don M. Howell, Alma, Mich.
Secretary-Treasurer: Dr. Louis D. Gomon, 308 Eddy Bldg., Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. R. A. Kelly, 304 N. Main St., Mitchell, S. D.
Secretary-Treasurer: Dr. J. C. Decker, 515 Frances Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Grady E. Clay, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. John R. Hume, 921 Canal St., New Orleans.

SOUTHWESTERN ACADEMY OF EYE, EAR, NOSE AND THROAT

President: Dr. Dake Biddle, 123 S. Stone Ave., Tucson, Ariz.
Secretary: Dr. M. P. Spearman, 1001 First National Bank Bldg., El Paso, Texas.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. Carl Wencke, Battle Creek.
Secretary-Treasurer: Dr. A. K. Zinn, Battle Creek.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. M. Harris, Johnstown.
Secretary-Treasurer: Dr. C. Wearne Beals, 41 N. Brady St., DuBois.

STATE

ARKANSAS STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. Virgil Payne, Pine Bluff.
Secretary-Treasurer: Dr. Raymond C. Cook, 1005 Donaghey Bldg., Little Rock.

COLORADO OPHTHALMOLOGICAL SOCIETY

President: Dr. Melville Black, 424 Metropolitan Bldg., Denver.
Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.
Place: University Club, Denver. Time: 7:30 p. m., third Saturday of each month, October to May, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. Shirley H. Baron, 309 State St., New London.
Secretary-Treasurer: Dr. S. J. Silverberg, 201 Park St., New Haven.

Eye, Ear, Nose and Throat Club of Georgia

President: Dr. Grady E. Clay, 384 Peachtree St. N. E., Atlanta.
Secretary-Treasurer: Dr. J. Mason Baird, 511 Medical Arts Bldg., Atlanta.

Indiana Academy of Ophthalmology and Oto-Laryngology

President: Dr. Marlow W. Manion, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Edwin W. Dyar Jr., 23 E. Ohio St., Indianapolis.
Place: Indianapolis. Time: First Wednesday in April.

Iowa Academy of Ophthalmology and Oto-Laryngology

President: Dr. H. H. Lamb, American Bank Bldg., Davenport.
Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.
Place: Davenport.

Louisiana-Mississippi Ophthalmological and Otolaryngological Society

President: Dr. D. C. Montgomery, 301 Washington Ave., Greenville, Miss.
Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

Michigan State Medical Society, Section of Ophthalmology and Otolaryngology

Chairman: Dr. O. B. McGillicuddy, 124 W. Allegan St., Lansing.
Secretary: Dr. A. R. McKinney, 330 S. Washington Ave., Saginaw.

Minnesota Academy of Ophthalmology and Otolaryngology

President: Dr. Hendrie W. Grant, 330 Lowry Medical Arts Bldg., St. Paul.
Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

Montana Academy of Oto-Ophthalmology

President: Dr. Roy Grigg, Bozeman.
Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

New Jersey State Medical Society, Section on Ophthalmology, Otology and Rhinolaryngology

Chairman: Dr. James S. Shipman, 542 Cooper St., Camden.
Secretary: Dr. Wright McMillan, 23 Passaic Ave., Passaic.

New York State Medical Society, Eye, Ear, Nose and Throat Section

Chairman: Dr. Algernon B. Reese, 73 E. 71st St., New York.
Secretary: Dr. Chester C. Cott, 333 Linwood Ave., Buffalo.

North Carolina Eye, Ear, Nose and Throat Society

President: Dr. A. G. Woodward, 100 S. James St., Goldsboro.
Secretary-Treasurer: Dr. M. R. Gibson, Professional Bldg., Raleigh.

North Dakota Academy of Ophthalmology and Oto-Laryngology

President: Dr. N. A. Youngs, 322 De Mers Ave., Grand Forks.
Secretary-Treasurer: Dr. F. L. Wicks, 516–6th St., Valley City.

Oregon Academy of Ophthalmology and Oto-Laryngology

President: Dr. L. O. Clement, 406 State St., Salem.
Secretary-Treasurer: Dr. Paul Bailey, 833 S. W. 11th Ave., Portland.
Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

Rhode Island Ophthalmological and Otological Society

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Society Library, Providence. Time: 8:30 p. m., second Thursday in October, December, February and April.

South Carolina Society of Ophthalmology and Otolaryngology

President: Dr. S. B. Fishburne, 1430 Marion St., Columbia.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

Tennessee Academy of Ophthalmology and Otolaryngology

President: Dr. J. B. Stanford, 899 Madison Ave., Memphis.
Secretary-Treasurer: Dr. W. D. Stinson, 124 Physicians and Surgeons Bldg., Memphis.

Texas Ophthalmological and Oto-Laryngological Society

President: Dr. A. N. Champion, 705 E. Houston St., San Antonio.
Secretary: Dr. Dan Brannin, 1719 Pacific Ave., Dallas.

Utah Ophthalmological Society

President: Dr. A. E. Callaghan, Boston Bldg., Salt Lake City.
Secretary-Treasurer: Dr. Rowland H. Merrill, 1010 First National Bank Bldg., Salt Lake City.
Place: University Club, Salt Lake City. Time: 7:00 p. m., third Monday of each month.

Virginia Society of Oto-Laryngology and Ophthalmology

President: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.
Secretary-Treasurer: Dr. M. H. Williams, 30½ Franklin Rd. S. W., Roanoke.

West Virginia State Medical Association, Eye, Ear, Nose and Throat Section

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

Akron Academy of Ophthalmology and Otolaryngology

President: Dr. L. E. Brown, Second National Bldg., Akron, Ohio.
Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron, Ohio.
Time: First Monday in January, March, May and November.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. Arthur G. Fort, 478 Peachtree St. N. E., Atlanta, Ga.
Secretary: Dr. Lester A. Brown, 478 Peachtree St. N. E., Atlanta, Ga.
Place: Grady Hospital. Time: 6:00 p m., second Wednesday of each month from October to May.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.
Secretary: Dr. Fred M. Reese, 6 E. Eager St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Birmingham Eye, Ear, Nose and Throat Club

President: Each member, in alphabetical order.
Secretary: Dr. N. E. Miles, 408 Medical Arts Bldg., Birmingham, Ala.
Place: Tutwiler Hotel. Time: 6:30 p. m., second Tuesday of each month, September to May, inclusive.

Brooklyn Ophthalmological Society

President: Dr. E. Clifford Place, 59 Livingston St., Brooklyn.
Secretary-Treasurer: Dr. Frank Mallon, 1135 Park Pl., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. James G. Fowler, 412 Linwood Ave., Buffalo.
Secretary-Treasurer: Dr. Sheldon B. Freeman, 196 Linwood Ave., Buffalo.
Time: Second Thursday of each month.

Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga, Tenn.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

Chicago Ophthalmological Society

President: Dr. Georgiana Dvorak-Theobald, 715 Lake St., Oak Park, Ill.
Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cincinnati Ophthalmic Club

Chairman: Each member, in rotation.
Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.
Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

Cleveland Ophthalmologic Club

Chairman: Dr. Albert J. Ruedemann, Cleveland Clinic, Cleveland.
Secretary: Dr. B. J. Wolpaw, 2323 Prospect Ave., Cleveland.
Time: Second Tuesday in October, December, February and April.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Clerk: Dr. W. S. Reese, 1901 Walnut St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. Harry M. Sage, 9 Buttles Ave., Columbus, Ohio.
Secretary-Treasurer: Dr. Hugh C. Thompson, 289 E. State St., Columbus, Ohio.
Place: The Neil House. Time: 6 p. m., first Monday of each month.

Corpus Christi Eye, Ear, Nose and Throat Society

Chairman: Dr. F. K. Stroud, 416 Chaparral St., Corpus Christi, Texas.
Secretary: Dr. Arthur Padilla, 414 Medical Professional Bldg., Corpus Christi, Texas.
Time: Second Friday of each month from October to May.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. Maxwell Thomas, Medical Arts Bldg., Dallas, Texas.
Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month from September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Arthur S. Hale, 1609 Eaton Tower, Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. L. A. Hulsebosch, 191 Glen St., Glen Falls.
Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. R. A. Gough, 602 W. 10th St., Fort Worth, Texas.
Secretary-Treasurer: Dr. Charles R. Lees, 806 Medical Arts Bldg., Fort Worth, Texas.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

Grand Rapids Eye, Ear, Nose and Throat Society

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. J. Charles Dickson, 1617 Medical Arts Bldg., Houston, Texas.
Secretary: Dr. William J. Snow, 708 Medical Arts Bldg., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

Indianapolis Ophthalmological and Otolaryngological Society

President: Dr. C. W. Rutherford, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: Indianapolis Athletic Club. Time: 6:30 p. m., second Thursday of each month from November to June.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. E. N. Robertson, Concordia, Kan.
Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.
Time: Third Thursday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

Chairman: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.
Secretary-Treasurer: Dr. Paul Nilsson, 211 Cherry Ave., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

Los Angeles Society of Ophthalmology and Otolaryngology

President: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.
Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:00 p. m., fourth Monday of each month from September to May, inclusive.

Louisville Eye, Ear, Nose and Throat Society

President: Dr. Gaylord C. Hall, Brown Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. Charles K. Beck, Starks Bldg., Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

Medical Society of the District of Columbia, Section of Ophthalmology and Otolaryngology

Chairman: Dr. Earle Breeding, 1801 I St. N. W., Washington.
Secretary: Dr. Elmer Shepherd, 1606–20th St. N. W., Washington.
Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Otolaryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. Sam H. Sonders, Medical Arts Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

Milwaukee Oto-Ophthalmic Society

President: Dr. Herbert G. Smith, 411 E. Mason St., Milwaukee.
Secretary-Treasurer: Dr. John B. Hitz, 411 E. Mason St., Milwaukee.
Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

Montgomery County Medical Society

Chairman: Dr. H. V. Dutrow, 1040 Fidelity Medical Bldg., Dayton, Ohio.
Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.
Place: Van Cleve Hotel. Time: 6:30 p. m., first Tuesday of each month from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. L. de G. Joubert, 690 Dunlop St., Montreal, Canada.
Secretary: Dr. K. B. Johnston, 1509 Sherbrooke St. W., Montreal, Canada
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Guy Maness, 119–7th Ave., Nashville, Tenn.
Secretary-Treasurer: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

New Haven Ophthalmological Society

President: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.
Secretary: Dr. Frederick A. Wies, 255 Bradley St., New Haven, Conn.

New Orleans Ophthalmological and Otolaryngological Society

President: Dr. E. G. Walls, 619 Maison Blanche Bldg., New Orleans.
Secretary-Treasurer: Dr. W. B. Clark, 1012 American Bank Bldg., New Orleans.
Place: Louisiana State University Medical Bldg. Time: 8 p. m., second Tuesday of each month from October to June.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. David H. Webster, 140 E. 54th St., New York.
Secretary: Dr. Robert K. Lambert, 10 101–15th Ave., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

New York Society for Clinical Ophthalmology

President: Dr. Arthur M. Yudkin, 257 Church St., New Haven, Conn.
Secretary: Dr. Benjamin Esterman, 515 Park Ave., New York.
Place: Squibb Hall, 745–5th Ave. Time: 8 p. m., first Monday of each month from October to May, inclusive.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. J. T. Maxwell, 1140 Medical Arts Bldg., Omaha.
Secretary-Treasurer: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

Passaic-Bergen Ophthalmological Club

President. Dr. R. N. Berke, 430 Union St., Hackensack, N. J.
Secretary-Treasurer: Dr. T. A. Sanfacon, 340 Park Ave., Paterson, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

Philadelphia County Medical Society, Eye Section

Chairman: Dr. Walter I. Lillie, 255 S. 17th St., Philadelphia.
Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
Time: First Thursday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Adolph Krebs, 509 Liberty Ave., Pittsburgh.
Secretary: Dr. George H. Shuman, 351–5th Ave., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Richmond Ophthalmological and Oto-Laryngological Society

President: Dr. Rudolph Thomason, Professional Bldg., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

Rochester Eye, Ear, Nose and Throat Society

President: Dr. Edwin S. Ingersoll, 26 S. Goodman St., Rochester, N. Y.
Secretary-Treasurer: Dr. Charles T. Sullivan, 277 Alexander St., Rochester, N. Y.
Place: Rochester Academy of Medicine, 1441 East Ave. Time: 8 p. m., second Wednesday of each month from September to May.

St. Louis Ophthalmic Society

President: Dr. B. Y. Alvis, Carleton Bldg., St. Louis.
Secretary: Dr. Carl C. Beisbarth, 3720 Washington Blvd., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

San Antonio Ophthalmolo-Oto-Laryngological Society

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.
Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Matthew Hosmer, 384 Post St., San Francisco.
Secretary: Dr. Fred Boyle, 490 Post St., San Francisco.
Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except June, July and December.

Shreveport Eye, Ear, Nose and Throat Society

President: Dr. I. Henry Smith, Slattery Bldg., Shreveport, La.
Secretary-Treasurer: Dr. David C. Swearingen, Slattery Bldg., Shreveport, La.
Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. Walter W. Henderson, 407 Riverside Ave., Spokane, Wash.
Secretary: Dr. Robert L. Pohl, 407 Riverside Ave., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. James F. Cahill, 428 S. Salina St., Syracuse, N. Y.
Secretary-Treasurer: Dr. I. Herbert Katz, 713 E. Genesee St., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

Toronto Academy of Medicine, Section of Ophthalmology

Chairman: Dr. W. R. F. Luke, 316 Medical Arts Bldg., Toronto, Canada.
Secretary: Dr. W. T. Gratton, 216 Medical Arts Bldg., Toronto, Canada.
Place: Academy of Medicine, 13 Queens Park. Time: First Monday of each month, November to April.

Washington, D. C., Ophthalmological Society

President: Dr. Ernest Sheppard, 927 Farragut Sq. N. W., Washington, D. C.
Secretary-Treasurer: Dr. E. Leonard Goodman, 1801 I St. N. W., Washington, D. C.
Place: Episcopal Eye and Ear Hospital. Time: 7:30 p. m., first Monday in November, January, March and April.

Wilkes-Barre Ophthalmological Society

Chairman: Each member in turn.
Secretary: Dr. Samuel T. Buckman, 70 S. Franklin St., Wilkes-Barre, Pa.
Place: Office of chairman. Time: Last Tuesday of each month from October to May.